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ABSTRACT

This journal special issue contains the following articles on the role of science and Technology in accelerating sustainable development in the countries of the South: (1) "The History and Urgency of South-South Cooperation in Science and Technology" (John F.E. Ohiorhenuan, Amitav Rath); (2) "Challenges, Opportunities and Strategies: South-South Cooperation in Science and Technology in the 21st Century" (Mohamed H.A. Hassan); (3) "Change of Paradigm in Science and Technology Policy" (Carlota Perez); (4) "How Can South-South Cooperation Contribute to a Knowledge-Based Development Strategy?" (Clive Thomas); (5) "Some Principles, Criteria and Priorities for Knowledge Sharing in Science and Technology" (Jorge Ahumada-Barona); (6) "Some Priority Sectors and Specific Actions for South-South Science and Technology Cooperation" (Ousmane Kane); (7) "Knowledge-Based Industrial Development and South-South Cooperation" (Lynn K. Mytelka, John F.E. Ohiorhenuan); (8) "Cooperation in Science and Technology: Definitions, Questions and Visions" (Joseph O. Okpaku, Sr.); (9) "From Imitation to Innovation: Technology Transfer and Adaptation North-South and South-South" (Hokoon Park); (10) "S&T Innovation and Cooperation in Latin America" (Guilherme Ary Plonski); and (11) "India's Experience with TCDC" (Ashok Parthasarathi). A summary of current trends, perspectives, and events is also included. (MES)

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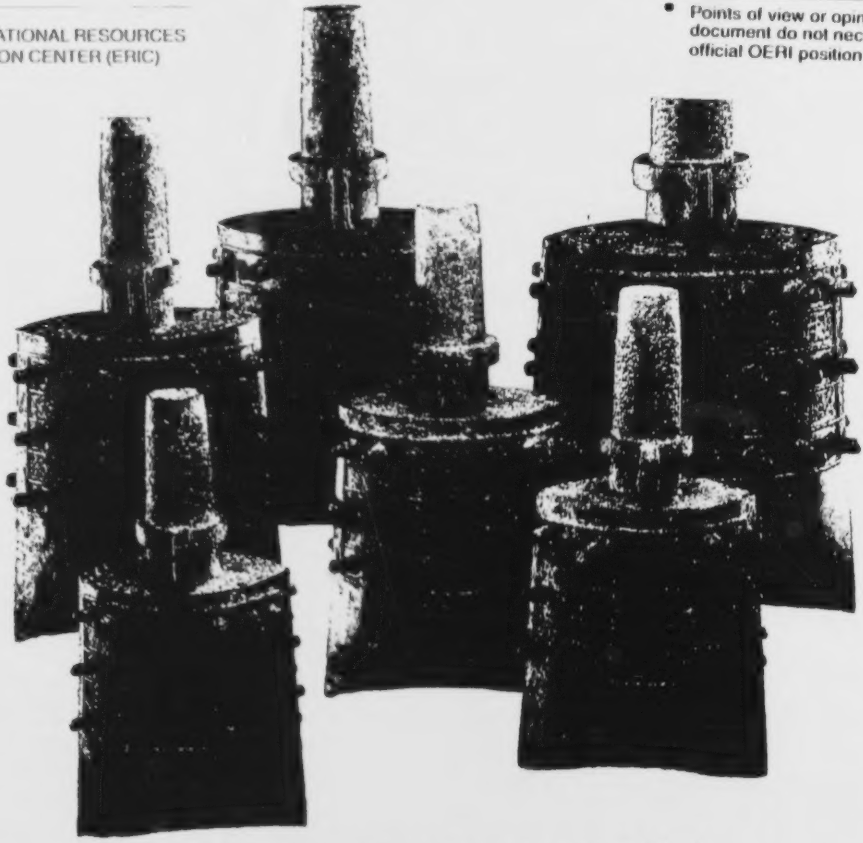

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DESIGNING THE FUTURE:

South-South Cooperation in Science and Technology

NUMBER ONE
2000

- OVERVIEW
- INNOVATION AND COOPERATION
- EXPERIENCE FROM THE REGIONS

2

UNITED NATIONS DEVELOPMENT PROGRAMME
SPECIAL UNIT FOR TECHNICAL COOPERATION AMONG DEVELOPING COUNTRIES

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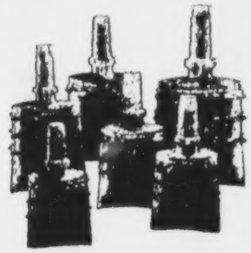
THE COVER DESIGNS USED ON ISSUES OF THIS JOURNAL PRESENT ARTIFACTS OR ARTWORKS THAT DEMONSTRATE THE CREATIVITY AND CONNECTIVITY OF PEOPLE ACROSS THE SOUTH.

Pitch, Metal and Power



In ancient China, orderly generation of musical sounds was equated with order in the universe and the security of the state. An official state bell or "chung" was the foundation of the whole system of standard weights and measures. The length of a tuning device was adjusted to give exactly the same note as the bell. That length was the state unit of measurement, which spurred development of sophisticated metal working to produce bells with perfect pitch. Correct pitch standards were so important that an Imperial Bureau of Music was created as part of the Imperial Bureau of Weights and Measures. Power and bells went together, as shown by a 1977 archaeological discovery of 65 tuned bells weighing 2 1/2 metric tons, and mounted on racks 465 feet long in a nobleman's tomb dating to about 500 B.C. This was two millennia before the first carillons were made in Europe. The six graduated bronze bells on the cover are also from the 6th century B.C.

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New Tools, New Coalitions

SPECTACULAR ADVANCES IN SCIENCE and technology are driving major changes in today's world and presenting special challenges and opportunities for the countries of the South. Developing countries are well aware that science and technology, properly harnessed, offers them extraordinary prospects for achieving rapid economic growth, industrialization, a cleaner environment, improved health, higher agricultural productivity, and better reproductive health. This raises two key questions:

- First, what approaches and methods should be employed to acquire, adapt, use and share appropriate technologies?
- Second, how can southern nations cooperate in research and development, application and production, and marketing and trade, when that offers economies of scale, time savings and other advantages?

As a step towards answering these questions and sharing the experience, a Forum on South-South cooperation in science and technology was held in Seoul this past February, sponsored by UNDP and the Republic of Korea. The Forum signaled a new vision of horizontal cooperation across the South aimed at putting the best science and technology brains to work on issues and opportunities of critical importance for developing countries. These include information and communication technology, tropical diseases and HIV/AIDS, biotechnology, sound governance, and sustainable development.

For this new vision to take root, however, new partnerships need to be forged among technology and policy specialists and institutes in the South. The best way to do that is through networks and coalitions devoted to specific themes and topics. Taking advantage of electronic connectivity, such coalitions could provide structural and operational flexibility, and permit an optimum reach for the production and the diffusion of innovations. They will also increase the visibility and availability of a wide range of R&D institutions, technical capacities and development experts within the South. In its programming and policy support for developing countries, the UNDP is firmly committed to promoting this vision.

This issue of *Cooperation South* draws on policy ideas and practical insights about science and technology for development that were offered by participants at the Seoul Forum. Our hope is that, in this way, wider audiences can share in an exciting vision of continuous innovation and continuous cooperation by, in and for the developing world.

Mark Malloch Brown

Mark Malloch Brown, Administrator
United Nations Development Programme

EDITOR'S FOREWORD

An Agenda for South-South Partnerships in Science and Technology

WHAT ROLE CAN INNOVATIONS in science and technology play to speed up the development process in the developing world?

What role must science and technology experts in the South play in that process?

To help answer these questions and open the way for a new era of South-South scientific exchanges, the Forum on South-South Cooperation in Science and Technology brought together policymakers and S&T experts from 37 countries between 14 and 17 February 2000. In organizing the Forum in Seoul, UNDP and the Republic of Korea sought to highlight the importance of tapping more of the enormous potential for S&T exchanges in the developing world. The Forum was also a means of mobilizing expertise to place S&T action proposals on the agenda of the South Summit held in Havana, Cuba, 10-14 April 2000.

Forum participants shared the concern that knowledge and information gaps between developed and developing countries threaten to widen the wealth gap between the North and the South. After a spirited analysis of current trends, constraints and opportunities the Forum concluded with a series of recommendations contained in the Seoul Accord, which is reproduced below on page 118. The document stresses the need for a new South-South partnership of networks linking the scientific and technological community in the South. Also needed, according to the Accord, are effective mechanisms to facilitate cooperation in R&D, education, and experience-sharing among Southern coalitions of firms, institutions and individual scientists.

In addition to hosting the Forum, the Republic of Korea served as a "visual aid" for participants to see firsthand a country whose high investments in S&T have paid handsome dividends—moving its people from an annual per capita GDP of US$80 in the 1950s to the current level of over US$10,000.

By putting together selected articles presented at the Seoul Forum, *Cooperation South* invites readers to join the debate on the role of S&T in accelerating sustainable development. The overview article puts S&T South-South cooperation in historical perspective. Next is a group of articles exploring challenges, opportunities, priorities and strategies for advancing a new agenda of scientific exchanges in the developing world. The forging of joint action programs combining the best scientific talents in government, private business and academia in a South-South nexus presents means of responding to everyday problems and pressing development needs. The authors argue further that the current technological revolution requires developing countries to radically rethink their policies and practical approaches to science and technology. They suggest that one way to bring desired change is to adopt South-South knowledge-building, knowledge sharing, and constant innovation as first steps towards successful global competitiveness. The strategy is to begin with select priority sectors such as knowledge-based industrial development. To succeed, S&T initiatives must have as their base a clear vision of the challenges, opportunities, strategies and practical programs to achieve realistic goals. The final group of articles anchors the debate in a number of practical experiences from Asia and Latin America. Cooperation among developing countries at similar levels of development is seen as an effective approach for finding solutions to shared development challenges in the South.

John F.E. Ohiorhenuan

The History & Urgency of South-South Cooperation in Science & Technology

by **JOHN F.E. OHIORHENUAN AND AMITAV RATH***

Are unequal technological advances facing the developing world with more intractable divisions, or just changing the directions South-South cooperation should take? John Ohiorhenuan, Director of UNDP's Special TCDC Unit, and Amitav Rath, Director of Policy Research International in Canada , see a shift occurring, not a split. Countries with widely differing experience have much to learn from each other in different arenas — economic, technological, environmental or institutional; traditional medicine or mass vaccination, literacy or education programmes; or foreign investment or trade promotion policies. Also, common problems with strong impact on the South, such as food security and tropical diseases, call for joint development and dissemination of solutions. The authors consider types of alliances and networks which could harness science and technology as a shared engine for growth throughout the developing world.

INTRODUCTION

The rapid advance of globalization and the emergence of a primarily technology-driven economy has changed the world significantly. The worldwide lowering of trade barriers, integration of capital markets, decentralization of production processes, and the dramatic advances in information and communications technology combine to indicate a radically different agenda for international development cooperation.

*** The views expressed here are the authors' and not necessarily those of the United Nations. The assistance of Yiping Zhou and Cosmas Gitta, Editors of *Cooperation South*, in preparing this article is gratefully acknowledged.**

The aspirations of the developing countries are in flux. In vast parts of the developing world, millions of people still lack the basic needs of meaningful existence — food, shelter, health services, clean water, and education. At the same time, many countries of the South are poised to harness the potential of S&T to improve the living standards of their people. Many developing countries have become successful innovators with large and growing pools of scientifically trained experts, some of whom are involved in the highest technology sectors.

Science is one component of the codified and organized knowledge that has existed in all societies at all times. Similarly, technology — the mix of knowledge, organization, procedures, standards, equipment and human skills which are combined appropriately to produce socially desired products — has also existed in all societies in all times. What is new, and of growing importance, is the systematic pursuit of scientific knowledge and its rapid use in meeting concrete human needs. The existence of science and technology haves and have-nots in the South raises the question as to what alliances, strategies and mechanisms are best suited to harnessing S&T for development throughout the developing world.

This overview paper briefly traces the history of South-South cooperation to underscore the urgency of such coalitions in science and technology if developing countries are to benefit from globalization.

SOUTH-SOUTH COOPERATION: AN HISTORICAL PERSPECTIVE

Origins

After World War II, as many developing countries were emerging from colonial rule, they began questioning the basis of the international system of economic relations and set out to jointly advance proposals for changing its structure and management. This early period of collective action by the South was marked by the formation of the Non-Aligned Movement (NAM) in 1961 and the Group of 77 (G77) in 1964.

Cooperation activities of the 1960s centred on emerging regional and subregional arrangements towards economic integration, trade and cooperation on political matters such as the Central American Common Market, the Central African Customs and Economic Union, and the Association of South East Asian Nations. Such cooperation was intended to expand market size, generate scale economies to support an accelerated industrialization strategy, and lay a foundation for more systematic integration of production structures across national boundaries (Benn 1996).

But these arrangements did not prove very successful in achieving the desired degree of economic cooperation. One barrier was inadequate communications and other infrastructural linkages. More important, most developing countries were mainly primary producers at this time, and so resource endowments and export baskets were too similar between countries within a region. Trade relations consisted chiefly of the exchange of primary products of the South for manufactures from the North. Thus, at the outset, the call for South-South cooperation arose as much from political and ideological desiderata as from technical-economic imperatives.

The 1970s were marked by great optimism about the ability of the South to reshape the international structure of power and economic relations in a more equitable direction. The increased activism of G77 and NAM during this period led to the adoption by the UN General Assembly of resolutions on the New International Economic Order and on new forms for technology transfer between countries. The UN established the United Nations Conference on Trade and Development (UNCTAD) to assist the South in the area of trade policy and promotion. The Commission for Science and Technology and the UN Fund for Science and Technology in Development (UNFSTD) were also established. In 1972, the UN General Assembly set up a Working Group to examine ways of intensifying technical cooperation among developing countries (TCDC). This led to the establishment in 1974 of a Special Unit within UNDP to promote TCDC (SU/TCDC). Arguably, the high point of deliberations on the applications of science and technology for development was the organization by the UN of the 1979 conference by the same name.

The 1980s proved to be more challenging. Many developing economies were battered by the high costs of debt, leading to reduced and often negative growth rates. In retrospect, most countries concede that there were many policy and implementation errors in their chosen development paths. However, the catalyst for the global changes is often identified as changes in US macroeconomic policy to arrest inflation and reduce public sector deficits, which were followed by most OECD countries. These policies led to quantum jumps in the cost of capital, severely magnifying the indebtedness of many developing countries. The 1980s also saw a reversal in what the South thought it had achieved in terms of reshaping the global agenda, including a reduction of the role of the UN Commission for S&T. By the late 1990s, UNFSTD had virtually disappeared. The funds available for TCDC within the UN system were insufficient to maintain visibility of these efforts. Thus, the decade ended with a period of disarray in developing-country thinking, bringing their dependence on the North into sharp focus.

The late 1980s and 1990s witnessed tremendous changes in the global economic, political and technological environment. The dissolution of the Soviet Union, the new aspirations of the countries within that bloc, the re-examination of the role of the State in almost all countries, the growing forces of globalization, and the phenomenal growth of large multinational firms have all contributed to a lowered expectation of the abilities of governments, and of the South, to change the international relations of production. It was claimed that the "end of history" has been reached, and that the future was one where capitalism, and countries which have embraced it more fully, have triumphed. The implicit corollary of this view is that the only hope for the laggards is to imitate the most successful countries as quickly as possible and to abandon all ideas of alternative approaches, solutions and visions.

This vision of the end of history may seem to indicate that, there is not much value or relevance to promoting South-South cooperation. However, while there has been much rhetoric, South-South cooperation has been a useful approach, and has generated many of the anticipated benefits, although in keeping with the modest inputs, the outputs have been small. Important reasons remain for improving and expanding on such cooperation.

TRADITIONAL AREAS OF COOPERATION

Economic, trade and financial cooperation

The available evidence, limited though it is, suggests that South-South cooperation received its first practical impetus from the motivation of increased trade and investment. Many regional groupings and organizations have been formed to promote economic relations. Another driving force was the importance attached by many developing countries, particularly larger ones and those with well-developed education and research systems, to the provision of scholarships and other assistance for the education and training of people from other countries of the South.

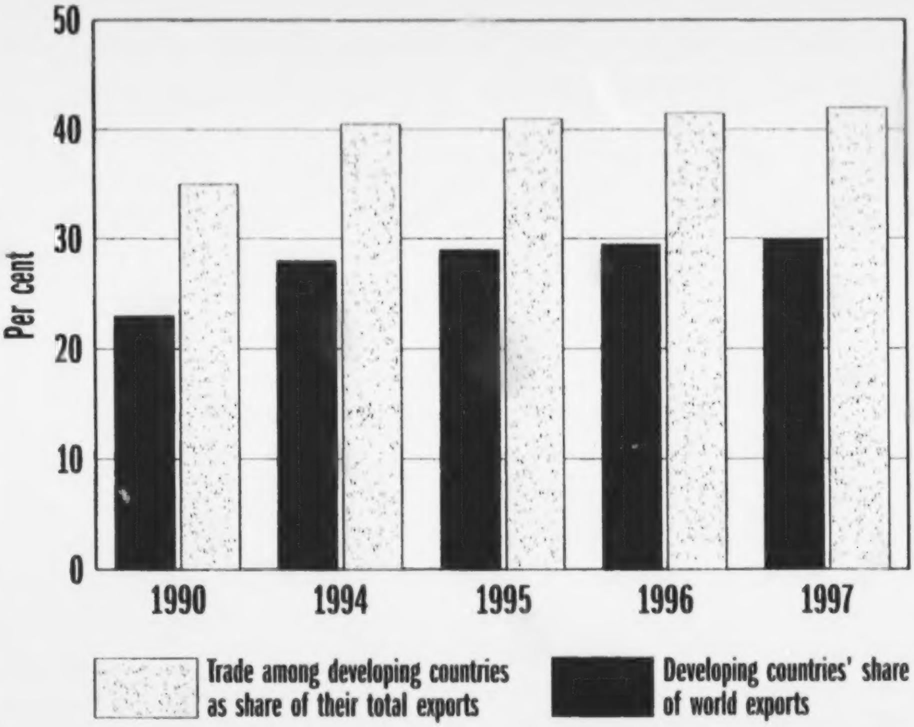
More recently, considerable attention is being paid to the exchange of experiences and policies in economic development, trade, foreign relations, public sector management, health and environment. This is a natural outgrowth of increased and differential experiences within the South.

Clearly, there is great potential for cooperation among countries in close proximity to each other and possessing common political, economic and socio-political interests. Thus it is not surprising that regional and subregional groupings have in the past been a popular and relatively effective mechanism for South-South cooperation.

The performance of regional groupings so far has been variable, and the South Commission (1990) noted the importance of revitalizing regional and subregional cooperation as part of any overall strategy. These groupings emerge from and are closely linked to perceived regional needs and interests, and as such provide an increasingly firm basis and structure for South-South cooperation through progressive widening of existing regional and subregional arrangements.

Regional and subregional economic

Figure 1—DEVELOPING COUNTRY EXPORTS



Source: United Nations General Assembly, 1999b

cooperation agreements have continued to grow, increasing from 39 in 1970 to 82 in the late 1990s. Such schemes have played a prominent role in stimulating South-South trade growth in the past two decades. It nearly doubled its share in total world trade (excluding fuels) in the 1970s, but was negatively affected by the development crisis in the early 1980s. Since the early 1990s, trade has again grown significantly in the South. While world trade is growing faster than world output, the developing countries' trade has grown more rapidly than overall world trade throughout most of the 1990s. Moreover, trade among developing countries is growing faster than their total exports. The most significant advances in South-South trade have occurred at the regional and subregional levels. Interregional trade among developing countries has also grown, albeit slowly.

Figure 1 shows the growth of developing countries' share of world exports and intra-South trade in the 1990s. In 1997, 42 per cent of the South's exports were directed to other Southern countries, compared to 32 per cent in 1990. This growth can in part be attributed to increased differentiation and growing complementarity (UN General Assembly, 1999b). Some Asian and Latin American countries have played a key role in expanding South-South trade and increasing the export of manufactures. Manufactured goods made up over 60 per cent of the South's exports in 1998, compared to 40 per cent in the late 1980s.

According to UNCTAD data, while foreign direct investment (FDI) has grown in importance for all countries in recent decades, developing countries as a group have increased their share of FDI inflows by a factor of almost five between 1986 and 1997. More interesting, however, is the sixfold increase, though from a lower base, in developing country participation as providers of FDI during this period. These outward flows originate largely in Asia. Within this larger global context, flows of FDI between developing countries are also rising, especially within subregions such as the ASEAN countries.

In Latin America and the Caribbean, they comprise over 90 per cent of FDI outflows to other developing countries. At the same time, for Latin America and the Caribbean, FDI inflows from South, East and Southeast Asia were more than 30 times greater in 1997 than in 1987. FDI from developing Asia to Africa is growing, while no noteworthy FDI has been recorded between Latin America and Africa (UNCTAD, 1999). FDI outflow from Africa is minimal and consists of a few small investments (UNCTAD, 1999).

Developing countries are increasingly viewing bilateral investment treaties as a means of enhancing South-South cooperation and promoting flows of FDI; UNCTAD has listed 66 such treaties that were concluded between developing countries in 1998. Efforts are also being made to assist small and medium enterprises (SMEs) in developing countries to enter into partnership exchange programs and subcontracts for the global market. Forty-five such exchanges have been set up in thirty countries, initially with UNIDO assistance, but now functioning independently (UN General Assembly, 1999b).

CONTINUITY AND CHANGE IN SOUTH-SOUTH COOPERATION

Since the 1980s, major changes have been occurring within the international economic system. Markets for money, finance and technology are becoming increasingly integrated globally, fuelled by technological advancement and an increasingly liberalized macroeconomic policy framework. Within these global markets, transnational corporations pre-

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The South can and should exploit its collective resources to acquire maximum countervailing power, and press for global consensus on the goals and management of the new international system.

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dominate, and their decisions thus have a more pronounced impact on world economic activity. The process of global integration has so far been highly unregulated, causing increasing unpredictability and instability in the world economy.

These changes accentuate the continued validity and relevance of South-South cooperation as a framework developing countries can use to participate more effectively in the newly emerging economic order. The South Commission (1990) argued that the South can and should exploit its collective resources to acquire maximum countervailing power, and press for global consensus on the goals and management of the new international system. It also conceded, however, that:

> *The countries of the South have failed to achieve [the required] solidarity. They have not been able to establish common priorities in keeping with the development interests of all, or to share technical and negotiating expertise, or to hold constructive South-South discussions in advance of negotiations…* (p.22)

Such solidarity has been difficult to achieve in the past and will probably be even more difficult in the future, since the developing countries are becoming increasingly differentiated and heterogeneous in their levels of economic and social development, technological capacities, and extent of integration into the global economy. A number of high-performing economies, primarily in Asia and Latin America and also in the other regions, have achieved high levels of economic growth and have shown enhanced capacity to respond to the new global challenges. Meanwhile poorer countries, with economic growth barely keeping pace with population growth, have found themselves unable to take advantage of opportunities presented by global changes. The differentiation and fragmentation of economic interests among developing countries will likely make it more difficult for the South to maintain common positions across the board in future North-South dialogue.

As the colonial past becomes increasingly remote for most developing countries, the ideology which once provided the vision and inspiration for cooperation has deteriorated, and the concept now lacks a forceful ideology to sustain it. Since it has become "almost impossible to find one unifying common interest which can bring them together...the strategy of South-South cooperation has to be built around clusters of common interests" (Gunatilleke, 1993, p.252). In this vein, the South Commission Report (1990) began to develop a "strengthened rationale" for South-South cooperation. It has suggested several new driving forces: the emergence of new complementarities among the countries of the South; the existence of surplus capital in some countries which could be profitably invested in other countries of the South; the need for joint management of natural resources; and the need to deal with common problems such as the environment and harnessing science and technology.

The growing diversity within the South will likely create new challenges for South-South cooperation, but it also opens up new opportunities. The South now has a wider range of development experiences to draw on. The progress made by Republic of Korea, China and India, and the success of Latin American countries such as Brazil in following a more S&T-based strategy, can provide valuable lessons for the South. The more dynamic developing economies are in an effective position to share with other countries the techniques and practices that have made them successful. Furthermore, the growing diversity of technological capacities between countries, and the corresponding wider range of goods and services available create new opportunities for trade and technology transfer within the South.

The growing diversity within the South will likely create new challenges for South-South cooperation, but it also opens up new opportunities. The South now has a wider range of development experiences to draw on.

While the "strengthened rationale" may establish a need and identify potential benefits of continued South-South cooperation, "the ideas are too technical and lack the power to inspire and move people in the way that the earlier motivating ideas for South-South cooperation did" (Jalloh, 1993, p.155). Thus, the development of a new vision is also important.

GLOBALIZATION: NEW URGENCY FOR COOPERATION IN S&T

Globalization and liberalization present a wide range of options and opportunities for the South. Individual countries in the South can seize these opportunities through increased South-South cooperation in general and in S&T in particular. In a recent article, Jeffrey Sachs warns that the world is faced with new and more intractable divisions on the basis of technology. In his view, countries failing to keep up with global technological advances are doomed to collapse, being unable to maintain or raise their living standards. Such failure results from undue dependence on a narrow range of raw material exports that are losing profitability on the world market.[1]

Clearly, globalization has its own winners and losers. Sachs notes that a small part of the globe, accounting for about 15 percent of the world's population, has mastery over nearly all of the world's technology innovations. Another half of the world's population has acquired the capacity to adopt foreign technologies. The bad news lies in the fact that about one-third of the world's population lives in countries that are technologically disconnected — unable to innovate or adopt foreign technologies. While virtually all developing countries have been adapting their domestic policies in recent years to the new global trade and macroeconomic regime, their ability to safeguard their own interests in a globalizing era remains limited by lack of capacity for institutional and technological innovation.

Although globalization has provided new opportunities for those countries with the policy instruments and institutional and technical capacities to participate in increased international trade and investment, many others are being left behind and marginalized. The gaps between the "haves" and the "have-nots", both between the North and the South and among the Southern countries, are widening.

In the face of these challenges, there is real urgency for developing countries to work together closely to build their capacity for innovativeness and creativity. No developing country on its own has the capacity to influence the processes that shape the evolution of the global economy. However, in adapting domestic institutional arrangements to the requirements of the global economic regime, each developing country has much to gain from cooperation with others. In particular, countries that are technologically disconnected can learn from those that have recently ascended to the status of technological innovators. The essence of South-South cooperation is that the wealth of knowledge and capacity in the South, when systematically mobilized and shared, can facilitate developing countries' effective participation in the global economy.

> ***Countries that are technologically disconnected can learn from those that have recently ascended to the status of technological innovators.***

Over the past fifty years, many developing countries have developed substantial knowledge and acquired capacity and experience in setting up dynamic institutions for social and economic management, as well as for science and technology development and environmental management. Many of them have developed new technologies and new competencies in renewable energy, genetic engineering and biotechnology, electronics and semiconductors, and information and communication technology.

Much useful and practical knowledge generated in the South can be shared beyond the body of knowledge formally declared as science. This includes traditional knowledge of medicines, ecosystems, social formations, and the sustainable use of resources. It also includes knowledge gained from more modern social experiments, such as large-scale vaccination or health delivery programs;

extension programs to improve literacy or agricultural productivity; the experience in Chile in stabilizing the flows of portfolio investments and in designing social insurance schemes; the recent experiences in a number of Asian countries, and Brazil and Mexico, of dealing with shocks to the financial system; and the various experiences in the promotion of trade, negotiations in WTO, in changing intellectual property rights (IPR) regimes, and in promoting domestic capacity in education, science and technology.

Another reason for cooperation in S&T is the existence of common problems within the South. Science and technology are likely to be key factors in solving problems such as food security and tropical diseases. Some such issues have little direct impact on the countries of the North, and are thus unlikely to given priority in the North's scientific research. South-South cooperation in these areas could be very valuable in finding and disseminating effective solutions.

Much useful and practical knowledge generated in the South can be shared beyond the body of knowledge formally declared as science — including traditional knowledge of medicines, ecosystems, social formations, and the sustainable use of resources, and knowledge gained from modern social experiments such as large-scale vaccination or health delivery programs.

Cooperation not only augments efforts and inputs, but can also bring alternative perspectives and approaches to the solution. Moreover, cooperation allows for greater scope for the resulting applications and innovations and thus potentially greater rewards. Sharing knowledge does not reduce its original value, but often increases it by expanding its boundaries and applicability. This does not always apply to individual private owners of knowledge whose objective is securing monopoly profits from patents and know-how, nor does it mean that the movement of knowledge and its applications are without cost. But in an ironic development where IPR issues have become more contentious, new developments in knowledge and innovation are increasingly pushing into obsolescence the older paradigm of the economics of scarcity, which has dominated our thinking, but is more relevant to traditional products.

As the rate of technological change increases globally and the range of knowledge required for specific innovations expands, there is a growing need for strategic alliances and network structures to increase the pool of knowledge available and to reduce the risks to each individual partner. Alliances and networks can take many forms and involve various types of actors, such as producers, suppliers, universities and research institutions, in different combinations for different purposes. Such efforts can increase transaction costs but, if well managed, can increase the rate of successful innovation. There is considerable value to increasing Southern-driven networks, with and without Northern partners.

CHALLENGES

Advances in S&T can both open up new opportunities to developing countries and also represent a serious threat. The pace of scientific and technological change over the past few decades is such that the knowledge base required to retain a competitive position in the world economy is growing rapidly, and traditional sources of comparative advantage are eroded. Economic success requires developing countries to rapidly build up their own capabilities to select the technologies most suitable for their circumstances and adapt them to make them appropriate, ultimately improving the ability to develop technologies suited to their own needs. Many common needs can be analysed in the context of the new opportunities and threats to develop a framework of priorities for a future South-South cooperation agenda. For convenience they are grouped below under labels such as environment, poverty, and technologies such as biotechnologies, information and communications, and so on, but in reality many of these converge in various ways. For instance, improved use of bioresources can also address other needs, such as poverty alleviation, sustainable development and energy shortages, and each of these directions can be promoted by the new advances in biotechnology, ICT, computation and so on. In priority setting, it is important to recognize that many of these themes emerge from several different dimensions simultaneously.

Poverty

The vast majority of the poor still live in the South. More than one billion people in developing countries are living in absolute poverty, with per capita incomes below US$1 per day, and no access to clean water and sufficient food to sustain their energy.

Development experience since the 1950s has shown that a rapidly expanding economy is a necessary condition, though by no means sufficient by itself, in order to improve the well-being of people and satisfy their basic needs. An appropriate development strategy is required to provide jobs for the South's growing labour force and create the resources to satisfy requirements for food, shelter, health, and education. It does not follow, nor is it possible in many cases, for the South to take the same industrialization path as the North did. Growth can reduce poverty only if complemented by specific economic and social policies to that end, including strong efforts to manage population growth, redistribute scarce productive assets such as land, and develop human resources through mass education, particularly in science and technology.

The improved welfare of the people of the South is the key reason for seeking to achieve higher developmental goals. Any welfare improvement strategy must aim to increase the capacity of people to earn a reasonable standard of living, which requires the creation of new and more productive employment opportunities in both rural and urban areas. Today in most countries of the South, the majority of people live in rural areas, and so increased agricultural productivity and greater use of bioresources are obvious areas for attention. However, the South can expect large migrations of rural populations to urban centres. In the next 25 years over 60 cities will emerge in the South with populations over ten million, and present large cities such as Sao Paulo, Lagos, and Beijing will also grow further. All these people will need jobs, shelter, energy, water, sewerage, transportation and so on. A whole set of issues will need to be successfully tackled if the urban centres are not to become increasingly chaotic, polluted and dysfunctional.

Small and medium-sized enterprises (SMEs) have a high potential for stimulating economic growth in the South, providing significant employment with relatively low investment requirements and high utilization of local raw materials. Historically, SMEs have played an important role in the process of industrialization in market economies. The experience of some Asian countries shows that SMEs create more jobs per unit of capital invested than larger enterprises, and can contribute significantly to improving the livelihood in both urban and rural areas. Many new technologies offer ways to improve the performance and efficiency of SMEs, and others provide new economic activities that can be undertaken by small-scale enterprises. The countries of the South would be wise to tap the potential of SMEs for job creation, while recognising that SMEs are only one aspect of successful industrialization.

Health and education

The populations of the developing world are burdened by many diseases whose transmission depends upon a warm climate. Malaria, for example, is estimated to kill 1 to 2.5 million people per year and is heavily concentrated in poor tropical countries, particularly within sub-Saharan Africa, due to climate and ecological conditions. However, the development of a malaria vaccine appears not to be high on the international agenda. The Wellcome Trust found that only US$80 million per year is spent on malaria research, with only a small fraction of that spent on vaccines. The large pharmaceutical firms of the North believe there is no market in malaria, as a vaccine would be costly to develop and may not produce sufficient financial rewards if copied by other firms or international agencies. Individual developing countries typically do not have the financial means to develop a vaccine alone, and their successes can be increased with greater cooperation.

Although the AIDS virus has infected over 33 million people globally, roughly 95 per cent of all HIV cases are in the developing world, with over two-thirds of those in sub-Saharan Africa. The drug treatments used to attempt to control the disease in the North are far too expensive for the poorest countries to afford. What little vaccine research exists is severely underfunded and tends to focus on specific viral strains and patterns of transmission prevalent in North America and Europe. The countries of the South thus cannot expect to rely entirely on AIDS research conducted in the North without their own efforts, individually and collectively.

Ironically, the 21st century is called the knowledge age, but more than 130 million children of primary school age in developing countries are growing up without access to basic education. According to UNICEF, nearly a billion people, two-thirds of them women, are currently "unable to read a book or sign their names — much less operate a computer or understand a simple application form. This suggests that efforts to bridge the digital divide by enhancing the capacity for innovation and diffusion of technology have to start by improving access to basic education in developing countries.

Connectivity

Globalization has significantly increased the need for and reliance on knowledge generation and processing. Countries and firms lacking access to modern telecommunications systems cannot effectively participate in the new global economy because telecommunications facilitate market entry, improve customer service, reduce costs, and help increase productivity. Communications are also an integral part of financial services, commodity markets, media, and transportation, as well as wholesale and retail business.

Although access to information resources is critical to understanding the world and effecting desirable socioeconomic transformation, their growing commoditization and privatization make many of the countries of the South ineligible to use new information technology for development purposes. In a sense, the growing trend to privatize information services, markets and telecommunications carriers contributes to the widening gap between information haves and have-nots (Sy, 1999, pp. 326 ff.). J. Habib Sy has observed that at least 80 percent of the world's population lacks the most basic telecomunications. About 55 percent of the world population lives in countries with less that 5 per cent of the world's telephone lines, and more than half of the world's population has never used a telephone. Similarly, Eastern Europe, Asia, Africa, the Arab world, Latin America, and the Caribbean have less than 6 percent of computers connected to the Internet. Many developing countries are making great efforts to access the Internet, but the cost remains an obstacle since it costs three to four times more to surf the net in Africa than it does in the United States or Western Europe (Sy, 329).

Environment

The environmental hazards faced by developing countries are numerous. Key threats include the continuous degradation of cultivated land; desertification in arid and semiarid zones; tropical deforestation; severe squalor and pollution in large cities; and the release of noxious gases and the discharge of untreated industrial effluents. With continued population growth in the South and rising levels of wealth and consumption, further pressures on the environment are inevitable.

The increasing environmental stresses are linked to many factors. The pressures of feeding the South's rapidly expanding population has in some countries led to shortening of traditional crop rotation cycles, such that land is cultivated without respite and soil becomes depleted. The need for additional agricultural land begets deforestation, aggravated by commercial ventures seeking new sources of timber.

Industrialization and economic growth are responsible for many environmental dangers in the South, as in the industrialized world. Air pollution caused by emissions from fossil fuel combustion is a growing problem, as is the contamination of water resources caused by uncontrolled disposal of industrial wastes. Continued rapid rural-urban migration in the countries of the South will create additional demand for housing, transport, and energy, requiring enormous resources. Innovative ways of providing these services at lower financial and environmental costs are urgently needed.

The tasks of managing shared resources and dealing with common environmental problems require collective action within the South, as appropriate environmental strategies must be sensitive to the effects of domestic actions on neighbouring countries. Areas calling for close cooperation include the management of shared water resources and irrigation systems, energy generation and conservation, and the prevention of floods and erosion. Knowledge and experience in the management of resources could be extremely valuable to other countries and regions facing similar challenges, especially in similar ecosystems. There is also great scope for cooperation in pollution control, in the management of offshore oil exploration in regional seas or coastal areas, and in the use of remote-sensing techniques to assess natural resources.

One vital area for South-South cooperation is the energy sector. For many people in the South, the supply of grid electricity is either unstable or nonexistent. The availability of energy is critical for economic and industrial development, and so the emerging consensus on the role of fossil fuels in promoting global warming is likely to put new pressures on the South. In order to evolve a sustainable pattern of long-term development, it will be crucial for developing countries to increase the energy supply from renewable sources and improve energy efficiency in all sectors. The South's capacities in the energy sector are significant, as countries such as Brazil, China, India, Mauritius, Nepal and South Africa are now leaders in the field of renewable energy. Pooling of the South's resources in energy R&D and arriving at negotiated agreements on responses to global warming could provide significant benefits for all concerned.

Developing countries have so far allowed the North to take the lead in raising environmental issues and proposing action. The countries of the South need to develop a comprehensive position on environment and development in order to ensure that their interests are adequately represented in the global environmental agenda. A common position is also crucial for more effective participation in negotiations with the North on the development and sharing of technologies for energy conservation and pollution control.

NEW POSSIBILITIES

Technical innovations and leapfrogging

While the needs of the South provide one side of the matrix for weighing possible emphases of effort, the possibilities provided by new capacities and new developments in science and technology form another side of the matrix.

Some key areas of scientific research and technological innovation are widely applicable, and joint activity would generate significant benefits, including biotechnology, microelectronics, and new materials, among others. These new technologies are difficult and costly to develop, but once developed are easy to imitate and use in production processes. As such, they offer vast opportunities for developing countries to accelerate their economic progress and leapfrog over intermediate levels of technology.

Leaping to the frontiers of productivity innovation can allow developing countries to gain comparative advantages, avoid repeating the mistakes made in the North, and use technologies that are cleaner, more effective, and less costly than outmoded ones.

Opportunities for leapfrogging may exist in both traditional areas, such as energy production and pulp and paper, and newer areas such as wireless and satellite communications, microelectronics and problems of environmental degradation. Technology choices allow countries to avoid choosing between environment and development, as the South has technological options that the developed countries did not have when going through their own industrialization. Developing countries can avoid the polluting development path followed in the North by implementing cleaner and more energy-efficient technologies sooner rather than later.

Reaping the benefits of leapfrogging, however, requires that countries have access to networks of technological knowledge in order to acquire knowledge about "best practices," options, and strategies. What is needed is not only the passive infrastructure and administrative capacities to participate in such networks, but also appropriate institutional mechanisms for exploiting the available knowledge and facilitating technological change.

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These technological changes do not just affect esoteric high technology economic activities, but can also provide opportunities in many traditional activities. Moreover, new advances in S&T carry major threats as well as promises to the South. Without an appropriate and increased response, the South will not only fail to take advantage of opportunities, but will also be increasingly at threat from the backwash of technological developments occurring elsewhere. Not making more appropriate use of these possibilities would be the single most important factor retarding the South in achieving the many goals toward which its peoples are striving.

Higher investments in R&D

While the knowledge base required to be competitive is expanding, financial and intellectual resources for science and technology remain scarce, but more so in the South than in the North. Indeed, while roughly 40 per cent of global GDP is in the countries of the South, they account for only 15 per cent of the world's scientific publications, and 1 to 2 per cent of patents filed in Europe and the US, according to UNESCO. Although this disparity in scientific and technological capabilities highlights the continued importance for the South of cooperation with Northern countries, it also presents a strong case for South-South cooperation in order to make more effective and efficient use of the South's scarce resources. This is particularly true for activities such as research and development that require a critical mass in order to function effectively. According to the South Commission, most developing countries devote no more than 0.5 per cent of their national income to R&D, compared to the 2 to 3 per cent allocated by developed countries. Pooling of research resources would bring developing countries closer to meeting the critical minimum of investment required, as well as minimizing duplication of efforts in some areas. In addition to allowing developing countries to reach the minimum thresholds, cooperation can also increase the economies of scale of the required efforts. The South Centre suggests that "with the increasing importance of economies of scale and expenditure on research and development, South-South cooperation may well become the most cost-effective means for the South to reach the new frontiers of science and technology".

Biotechnology

The South can expect rapid population growth and rising demand for food in the years to come, leading to diminishing agricultural land per head and mounting stresses on existing land. Biotechnology may become vital for ensuring long-term food security, as it has the potential to improve the productivity of the South's farming systems, reduce the quantity of chemicals used in agriculture, lower the cost of raw materials, and reduce some of the negative environmental impacts of conventional production methods.

Biotechnology and agricultural research are prime areas for South-South cooperation. Within regions and subregions, countries have common genetic bases and ecosystems. As such, they face many common problems, and research results could be widely applicable between countries. Since research in this area is complex and costly, countries should pool their resources and work jointly on projects of common interest, such as genetic enhancing centres and gene banks.

The development and application of biotechnology brings with it a multitude of challenges. The commercialization of biotechnology requires increasingly trans-sectoral capabilities, including knowledge of biosafety and IPR issues. It is increasingly clear that developing countries need to establish suitable regulatory systems, assess and manage the health and environmental risks of such products, and tackle issues of public education.

Microelectronics and ICT

The pace of industrialization can be greatly enhanced by efficient, rapid and cost-effective information flows, which are increasingly possible due to advances in information and communication technologies (ICTs). The ease and low cost of compiling and transmitting information has made it possible to unbundle production processes and spread out production plants to many locations. This opens the scope for Northern TNCs and other large corporations to subcontract production processes or parts thereof to SMEs in developing countries.

Advances in information technology have also made information about technology choices easier and faster to obtain. Electronic knowledge networking permits better access to and fuller assessment of technologies already in the public domain, as well as allowing diffusion of information on "best practices" in energy technology, pollution control, and clean manufacturing.

Many of the rapidly industrializing countries of the South are competing successfully with the North in software development and data management techniques. Well-known cases include the development in some ASEAN countries of high-speed communications corridors and provision of a basis for manufacturing hardware and electronic components; India's successful growth in the software sector; China's established competencies in many areas of manufacturing; and Republic of Korea's progress in several areas of ICTs. We may conclude that these nonuniform capabilities, if combined in and for specific applications, can provide a much more powerful set of inputs for innovation than if the opportunities are pursued in isolation.

STRATEGY AND FUTURE DIRECTION

Any long-term agenda must be embedded in a larger vision, a vision that is challenging, that has the support of many in the South and is in consonance with their aspirations and goals. Beyond that there must be an overall strategy and framework. This is important, as there are many issues, problems, needs, opportunities and ultimately a variety of actors with different responsibilities, capacities and objectives. An overall strategy and framework allows different actors to undertake their actions within a common and mutually supportive fashion. Developing any action plans requires one to consider not only the specific actions needed, but also issues of institutions, structures and mechanisms, resources, and finally systems of measuring whether there is appropriate and adequate progress in achieving the goals set out. Some points are laid out below which may be a useful resource for developing national policies and programs.

An overall strategy for South-South cooperation in science and technology should start by focussing on the smaller activities and programs already existing, building on bilateral and regional arrangements and expanding into more cross-regional activities. Since it is almost impossible to find one unifying common interest which can bring together all the countries of the South, the strategy of South-South cooperation should be built around clusters of common interests. For each cluster a group of countries would take the lead in response to their own national interests. Work would be required in identifying the special interest groups for each component and designing the appropriate institutional framework to implement such a program of cooperation.

One possible model for such a process is functional multilateralism — the negotiation of a series of agreements on a number of pressing issues. Functional multilateralism involves many players coming to the bargaining table at the same time, with the actors shifting over time and according to issue under consideration.[2] However, some issues and countries may be left out in this form of cooperation, especially smaller poorer countries, and so this model will need to be supplemented with strategies for more disadvantaged groups. Functional multilateralism can also be effective in discussions and negotiations involving both the North and the South, putting Southern governments on an equal footing with developed nations, since their participation is seen as essential to the process. Another means of involving the North is through triangular cooperation arrangements, in which cooperation between countries of the South is co-financed by Northern partner countries. Possible mechanisms for such arrangements need to be considered, as well as the role of international agencies, which can often provide useful convening mechanisms.

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International cooperation requires, as a prerequisite, that individual partner countries have a minimum of capacity, and thus that they undertake some minimum of national activities in science and technology. Areas where individual national effort is required include the integration of S&T into national development plans, with carefully selected sectoral priorities backed by adequate resources; increased spending on R&D from current levels; according higher priority to all educational activities; placing greater stress on education in basic sciences and effective systems of research; strengthening links between production units and R&D centres; and creating special facilities, such as venture capital funds for entrepreneurs harnessing new technologies for productive use.

The overall strategy should be need-based, focussing on applying science and technology to meeting the needs of the countries of the South and solving common problems. Effort should be made to identify areas of scientific research and technological innovation that are of immediate concern to the South and in which joint activity would be expected to generate significant near-term benefits. Examples of such areas include agriculture, renewable energy, tropical diseases, biotechnology, and information and communications technologies, among many others.

The strategy should also focus on the expansion of educational links within the South, with accent on scientific, technical and vocational courses, as well as the development of managerial and entrepreneurial skills. This could include establishing a network of Centres of Educational Excellence; expansion of fellowships and scholarships; exchanges of staff and teaching materials; and developing programs of collaborative research.

In the current context of economic reforms which give an increasing role to the private sector and the market, South-South cooperation needs to expand to include more market-driven actors. The new strategy must therefore include ways of incorporating actors who have not yet been widely involved in South-South cooperation activities. Productive enterprises, both public and private, can contribute to overcoming the South's knowledge gap by promoting technical change and encouraging enterprise and innovation. Possible areas of focus include joint production arrangements and R&D with transnational corporations from both North and South; promotion of small and medium enterprises; setting up consortia of consultancy and design firms; and promoting links between research institutions and productive enterprises to enhance the commercial use of research results. NGOs and other civil society groups may also have an important role in future cooperation activities.

Relatively easier areas of science and technology cooperation to be developed would be classical "low" technology, comprising older technologies with low science inputs. This is followed by applied sciences, if capabilities in basic sciences are available. The last area is typically science-based high technology, which is harder and more expensive to develop.

There is an imperative for greater follow-up, monitoring and evaluation of South-South cooperation activities. The practical assessment of projects and programs must be improved in order to clearly identify achievements. Efforts must be made to promote the value of and need for South-South cooperation, building on those achievements and communicating success stories to different stakeholders, particularly policymakers, in order to justify the allocation of resources for further co-operative activities. On this front, an overview should be prepared of what is being done by the UN development system in support of science and technology in the South.

Mechanisms

Much more analysis of mechanisms for South-South cooperation is needed in order to identify and evaluate existing mechanisms and determine whether new ones are needed. Possible mechanisms may be permanent or semipermanent, and could consist of networks or project specific institutions, among other possibilities. The strengths and potentials of existing institutions should be analyzed and more fully exploited. At the same time, structures and new institutions will be needed, and this need must be balanced with financial constraints. Continuing and systematic work in this area is required.

Resources

There is unanimous agreement that a lack of resources has been the critical shortcoming of South-South cooperation to date. Thus a key issue for the future is how to secure adequate resources for the implementation and follow-up of proposed programs and actions. While UNDP's allocations for TCDC have increased gradually over time, there is still considerable scope for improvement. National resources earmarked for cooperation programs can and should be increased. Certainly the richer and more advanced countries of the South should take the initiative in providing financial support for cooperation in science and technology. Other possible mechanisms for securing financial resources for South-South cooperation include triangular arrangements with countries of the North or richer Southern countries, and funding arrangements with the private sector. The possible role of multilateral banks should also be considered.

Actions

From this overall strategic framework, several possible recommended actions for the South can be drawn. At the national level, stronger education and on-the-job training in science and technology, combined with a more effective research system, is needed in order for Southern countries to develop their own capabilities. Internationally, cooperation in education and training remains an underutilized mechanism for South-South cooperation. Although a few countries have undertaken large programs of student exchange, the overall movement of students between developing countries remains small. To combat this, existing bilateral programs should be expanded with a fund for South-South exchanges of students and practitioners. Various mechanisms for offering more scholarships can be considered, including setting up a foundation for this purpose or working with existing institutions, such as the Third World Academy of Sciences (TWAS). As well, a network of Centres of Educational Excellence should be established in order to maximize the use of existing universities and technical colleges of high standing in the South. Teleconferencing can be used as a means of delivery for educational programs in order to make courses more available to students from all over the South. The pilot African Virtual University project is an example of how advances in ICT can be used to facilitate educational collaboration in this manner.

In addition to increasing the pool of scientifically and technically qualified personnel, it is also important to develop systems to utilize them more effectively. A network of Centres of Research and Technological Excellence in the South should be established and strengthened for advanced research, particularly in areas of high technology and environmental sciences. This could start slowly by appointing one or two such centres in more advanced developing countries and establishing regional centres on a pilot basis. Directories and databases of experts and institutions in the South can help to facilitate collaboration, and existing ones should thus be linked in order to arrive at a broad overview of what is taking place in research. Specific topics should be defined for further development and work on a South-South basis, for example in health, in biotechnology, and in policy. Collaborative research programs could be undertaken at regional and interregional levels in both conventional areas, such as agriculture and energy, and new areas of technology, such as biotechnology and microelectronics. Such research programs must be complemented by links with productive enterprises that could lead to greater commercial use of research results.

National policies for science and technology should be developed and/or updated in all countries of the South. Each country's S&T policy should have an openness to South-South cooperation, and could include policies regarding common needs of the South such as affordable and effective vaccines.

Special attention must be paid to the impacts of changing systems of intellectual property rights (IPR) for the South. The North is trying to further strengthen IPR systems to enlarge the monopolistic rights of their technology sellers. This issue is of particular importance in areas such as agriculture and pharmaceuticals, where patenting may threaten the South's ownership of its bioresource base and traditional knowledge and methods. The countries of the South would benefit from establishing a common position and strategy on the revisions needed in trade-related intellectual property rights (TRIPs) in order to promote their own socioeconomic interests. ▣

Note

This article draws heavily on an earlier draft prepared for the UNDP Special Unit for Technical Cooperation among Developing Countries by Amitav Rath and Sherry Lealess of Policy Research International Inc (Canada).

*See Amitav Rath and Sherry Lealess "The High Level Forum on South-South Cooperation in Science and Technology: An Overview Document at www.pri.on.ca/seoul

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NOTES

[1] Jeffrey Sachs, "A new map of the world" in *The Economist*, June 24, 2000, pp81ff.

[2] J. Habib Sy, "Global Communications for a More Equitable World" in *Global Public Goods*, Inge Kaul, Isabelle Grunberg and Marc A. Stern, Eds., New York, New York Oxford University Press, 1999, pp. 326ff.

Challenges, Opportunities and Strategies: South-South Cooperation in Science and Technology in the 21st Century

by MOHAMED H.A. HASSAN

How to devise science and technology initiatives that seek to solve everyday problems and critical development needs? The best route is to forge joint action programs combining the best scientific talents in governments, private business and academia, and pursuing common strategies of South-South cooperation. Mohamed Hassan, Secretary General of the Third World Academy of Sciences, surveys the issues needing attention and suggests steps to significantly increase research and development capacities in the South.

THE SOUTH ENTERS the third millennium facing monumental challenges in its efforts for economic progress and sustainable and equitable development. At the core of these challenges is the ability of the South to participate in and benefit from the rapid advances in scientific research and technological innovations that now drive economic and social development. These powerful forces are largely controlled by industrialized countries in the North, and are mostly directed to address the problems and needs of rich countries. The South, as a whole, contributes little to modern science and technology. Yet, if acquired and properly utilized, new trends in science and technology offer immense possibilities for solving many of the problems impeding economic and social progress in the South.

The South should therefore intensify cooperative efforts to enhance its indigenous capacity to generate, manage and utilize science and technology in ways that address its own basic needs.

Vigorous regional and interregional efforts are needed to develop collaborative programmes in capacity building for scientific education and research, and to establish new alliances among academia, governments and industries to address real-life problems.

There are a number of challenges and opportunities for South-South cooperation in science and technology, and several strategies can be pursued to strengthen that collaboration. Such strategies, which must be firmly anchored to the best available science and technology in the South, are most likely to succeed through networked centres of excellence focusing on problems of common concern.

CHALLENGES TO SOUTH-SOUTH COOPERATION

The most critical challenge facing the developing world is how to bridge the huge gap between the North and the South in the production and utilization of scientific and technological knowledge. Measured in terms of publications, the science-rich North, representing 20 per cent of humanity, contributes more than 90 per cent of the world's share of current scientific knowledge. Meanwhile, the science-poor South, representing 80 per cent of humanity, generates less than 10 per cent of this knowledge. In terms of technological output, measured by patents, the inequality is much greater. The South's 1995 share of patents, held by the two largest and most international patent systems in the USA and Europe, amounted to less than 1 per cent of the world's total.

What is more disturbing is that the North-South divide in scientific output and technological innovations is constantly widening. On the one hand, the North, with its huge investments in research and development (R&D), is rapidly advancing the frontier of scientific knowledge. On the other hand, developing countries are spending small proportions of their gross domestic product (GDP) on R&D — often less than 1 percent. Put another way, the world's total R&D expenditure in 1994 was about US$470 billion; only 10 per cent of that amount was attributed to the South. This makes it very difficult for the South to develop the capacity to catch up.

Developing countries spend less than one per cent of their gross domestic product on R&D.

Huge investments in scientific research and knowledge in the past 30 years have been the driving force behind the considerable wealth and high living standards now being enjoyed by the North. In 1995, the income share of the richest 20 per cent of humanity was 86 per cent of the world's total. Other statistics tell the same story. For example, the ratio of income for the richest 20 per cent of humanity compared to that of the poorest 20 per cent rose from 30:1 in 1960, to 61:1 in 1991, to 82:1 in 1995.

Reducing these disparities is a major challenge facing South-South cooperation in the 21st century. Previous efforts by national governments and international development agencies to overcome poverty and stimulate growth in developing countries have not recorded much success. Rapid globalization, driven by revolutionary advances in technology and information and communication systems and characterized by economic liberalization, free trade, and increased competition, have often widened the gap between poor and rich nations. The impact of globalization on the composition of financial flows, for instance, has been dramatic. Overseas development aid, a major source of external funding for development projects in poor countries, slid from US$56.4 billion in 1990 to US$44.2 billion in 1996. At the same time, foreign direct investment and private financial flows soared from US$41.9 billion to US$256 billion. Such trends have benefited only a few developing countries with large economies.

The primary challenge, then, is how South-South cooperation can help the majority of developing countries close the knowledge gap and effectively respond to and benefit from rapid globalization by enhancing their capacities in science, technology and knowledge. Such efforts will serve as cornerstones for the transition of the South to sustainable economic growth and development.

The second important challenge is to find solutions to the critical real-life problems confronting most Third World countries. Such problems include poverty; tropical diseases; food, energy and water shortages; and their adverse impacts on biological resources, climate and water quality. Harvard University economist Jeffrey Sachs contends that since poor countries are mostly located in ecological zones different from those in the North, they face different health and agricultural problems and that those differences are often a fundamental cause of persisting poverty. The challenge for South-South cooperation, therefore, is how to mobilize the best science in the South and elsewhere and direct it towards development problems in the developing world.

OPPORTUNITIES FOR SOUTH-SOUTH COOPERATION

The revolution in information and communication technologies has created unprecedented opportunities to narrow the knowledge gap between North and South by providing equitable access to the world's stock of scientific knowledge to everyone, everywhere. Through electronic mail and the internet, data can now be instantly transferred across vast distances, providing science-poor countries with the possibility of access to the latest scientific and technological information for addressing local and global problems. In fact, scientists in the South with internet facilities can now communicate easily with each other and their colleagues in the North to form new virtual networks and global research teams.

But many members of the world community cannot fully participate in and benefit from this information revolution. Unfavourable economic conditions and the high cost of wire-line infrastructure have made it difficult to provide these facilities to people in poor Third World countries, particularly in remote areas. The total number of telephone lines in the 48 LDCs is 1 per cent of the number of lines in the USA. Only 1 per cent of the world's telephone lines are in Africa, and about half of these are in South Africa alone.

On the other hand, rapid advances in wireless digital systems based on satellites or cellular transceivers can provide a much less expensive and permanent solution to communication problems in developing countries. Among the many advantages of wireless over wire-based telecommunication systems are that they can be developed quickly and are not affected by natural hazards. Several developing countries — Argentina, Brazil and China, for instance — are investing heavily in digital communication systems. Telephone networks in such small countries as Botswana, Djibouti, Ghana, Maldives, Mauritius and Qatar, are now completely digital, bypassing the older wire-based systems and leapfrogging to this new technology. This trend deserves to be emulated by other developing countries. The new information age will soon make it possible for many scholars, teachers or students to acquire cheap small portable computers that provide access to virtually any source of information anywhere, anytime.

Another important opportunity is to apply innovative techniques in biotechnology and genetic engineering to improve food production, preserve the environment and natural resources, and combat tropical diseases. Most of the current research in this rapidly advancing field is carried out in the laboratories of the North. But several developing countries, including Argentina, Brazil, China, Cuba, India, Mexico and Singapore, have established research programmes in modern biology and biotechnologies of high standard. These countries are in a strong position to assist others in the South to develop their local capacities.

Still another opportunity for developing countries relates to their share of the world's natural resources. The developing world is blessed with vast natural resources and possesses most of the world's biodiversity, as well as much of the deeply rooted traditional knowledge associated with these genetic assets. The South, however, has not yet gained much from its natural riches. Many developing countries lack the scientific and technical skills and financial resources to protect and sustainably exploit these irreplaceable biological resources. In a world economy driven by globalization and competitiveness, the

South will likely find its natural resources to be one of its best comparative advantages.

Meanwhile, big multinational pharmaceutical and biotechnology companies in the North have expanded their bioprospecting and gene-hunting in developing countries. In 1990, world sales of medicine derived from plants discovered by indigenous people totalled US$43 billion. Yet, people in the South received little financial benefit from these commercial efforts. Similarly, the 1998 *World Development Report* noted that a unique plant in Madagascar used by a global pharmaceutical company to develop two anti-cancer drugs generated more than US$100 million in sales with no financial returns to the country. Such large developing countries as India, Brazil and China have devised biodiversity laws to protect their genetic resources from biopiracy. However, the trade-off between stricter protection laws as called for by India and China, and relatively liberal legislation as advocated by Brazil, must be carefully assessed against the ultimate goal of protecting local interests and encouraging foreign investment. Developing countries must work together to build their capacities in genomics science and develop skills in international property right and patent issues, to be able to negotiate bioprospecting agreements with foreign companies that would maximize the benefits to their economy and local communities.

STRATEGIES FOR SOUTH-SOUTH COOPERATION

Any strategy to promote South-South collaboration must bear in mind the diversity of countries in the South. Their size varies enormously. China has a population of 1.2 billion, almost twice the population of the 48 Least Developed Countries (LDCs) combined. Some large countries, such as Argentina, Brazil, China, India, Mexico, South Africa and South Korea, have enviable records of scientific achievement compared to the others. A few — for example, South Korea, Malaysia, Singapore and China (Taiwan) — have made considerable economic and technological progress in recent years. Yet, many LDCs have not experienced significant development for some time. Regardless of their size and stage of development, every country in the South lags behind every country in the North in terms of wealth, scientific and technical productivity, and military power.

The most productive and beneficial South-South cooperation strategies are those anchored to the best science in the South. Without the full engagement of the South's most outstanding institutions and most accomplished scientists, South-South cooperation will not make a real difference. For this reason, it is necessary to develop a comprehensive audit of institutions and individuals that have achieved excellence in scientific research and training in the South. The Third World Network of Scientific

Organizations (TWNSO), in collaboration with the Third World Academy of Sciences (TWAS) and the South Centre, recently took a major step in this direction. In 1998, the three organizations published a book profiling the capabilities of 430 scientific institutions of excellence in 52 developing countries. These institutions have expressed readiness to participate in regional, interregional and international networks, and scientific exchanges and training programmes for young scientists from other developing countries. Many of the institutions have achieved levels of competence comparable to institutions in industrialized countries.

Human resources development should be a top priority in South-South cooperation strategies. The dearth of highly qualified scientists and technologists in most Third World countries has hampered the development and application of science and technology to the socio-economic needs in the South. It also explains the large number of foreign consultants in the LDCs. As Thomas Odhiambo, former president of the African Academy of Sciences, recently observed, roughly 100,000 high-level experts, equivalent to the number of foreign experts working in Africa, were part of Africa's brain drain during the 1990s.

Major efforts, therefore, should be mounted to fully utilize institutions of excellence in the developing world to train young scientists from countries with inadequate research and training facilities. To facilitate this goal, governments in the South and international development agencies should co-sponsor a massive programme of scholarships to enable students to pursue graduate and postgraduate education in these institutions. South-South cooperation in postgraduate training at institutions of excellence in the South has several advantages. Apart from being much less expensive than training in the North, it promotes the indigenous generation and application of knowledge and could help slow the brain drain. Furthermore, training a new generation of scientists in Southern institutions will encourage these scientists to build scientific collaboration with their peers in the South and permanent links with the institutions where they were trained.

Roughly 100,000 high-level experts, equivalent to the number of foreign experts working in Africa, were part of Africa's brain drain during the 1990s.

An important initiative in this direction has recently been taken by the Third World Organization for Women in Science (TWOWS), in collaboration with the Third World Academy of Sciences (TWAS). With financial support from the Swedish Agency for Research Cooperation with Developing Countries

(SAREC), a postgraduate fellowship programme is enabling talented young female students from the LDCs to pursue PhD studies at centres of excellence in the South. The large number of applications — more than 150 for 25 openings — demonstrates the demand for such South-South initiatives.

The South's efforts to achieve science-led sustainable development depends on fully engaging its most able and talented minds. Special programmes, like the Math and Physics Olympiads, aimed at identifying and encouraging youthful talent, should be supported through South-South collaboration at the regional and interregional levels. Gifted children selected for these programmes should be nurtured in an environment conducive to the development of their talent. This can be achieved through the creation of a specialized system of schools and colleges for gifted children. The South Korean government pursued such a strategy when it established several highly competitive high schools for training talented children and the Korean Institute of Science and Technology (KIST), to enable them to pursue their university undergraduate education. The system has been instrumental in the development of a critical mass of highly qualified and talented leaders in science and technology. The creation of such a pool, in turn, has been a key factor in South Korea's unprecedented pace of economic growth.

Therefore, the *first element* in any strategy for South-South cooperation is to utilize the best research and training centres in the South to train young and talented scientists from other countries, especially those from the LDCs, to create a critical mass of world-class leaders able to address the critical problems facing the countries of the South. This measure should be reinforced by efforts to stem the migration of the best scientists from the South to the North seeking better economic and working conditions. In the South they should be provided incentives and adequate research facilities and be encouraged to get involved in national development programmes. A recent IMF study "How big is the brain drain?" presents dramatic and disturbing statistics. In several Third World countries, the migration rate of highly educated individuals to developed countries exceeds 30 per cent of the total at home. And for some countries, more individuals with college degrees live abroad than in their country of origin.

The *second element* in any strategy for South-South cooperation is to engage leading research institutions in the South in joint research projects aimed at finding solutions to critical real-life problems facing large regions of the South. Such problems include tropical diseases, food security, energy needs, soil and water management, deforestation and desertification. There can be substantial benefits for developing countries from regional and interregional cooperation in

FOUR ELEMENTS FOR A STRATEGY OF SOUTH-SOUTH COOPERATION IN SCIENCE AND TECHNOLOGY

- ***Science Leaders:*** Use the best centres in the South to train young talented scientists, create a critical mass of world-class leaders able to address critical problems in the South, and stem the brain drain.
- ***Problem Networks:*** Join leading institutions in research projects and networks to find solutions to critical real-life problems facing large regions of the South — such as tropical diseases, food security, energy, soil and water management, deforestation, and desertification.
- ***Innovative Experiences:*** Share innovative experiences in science and technology from developing countries that have directly benefited the quality of life.
- ***Authoritative Advice:*** Set up interdisciplinary panels of scientific leaders to offer independent, authoritative opinions to decision makers on critical issues, e.g. electronic communications, biotechnology, alternative energies, resource conservation, new materials.

science and technology, based on efforts to network centres of excellence to tackle specific development-oriented research problems. Although at different stages of development, many developing countries share similar social, cultural and economic roots. As an example, the Third World Network of Scientific Organizations (TWNSO) — with financial assistance from the Global Environment Facility (GEF) — has recently formed a network of centres of excellence in dryland biodiversity in 16 developing countries and designed a project to facilitate the sharing of successful experiences in the conservation and sustainable use of genetic resources. Networks to address other problems of critical importance to sustainable development — for example, centres focusing on the study of medicinal plants, fresh water and renewable energy — are being developed. These networks should take advantage of recent advances in cross-cutting technologies, such as biotechnologies and information and communication technologies, to enhance their efforts to create the new knowledge needed to address the problems of the South. This knowledge must be generated locally because it is not readily available in the North.

The *third element* is to promote the sharing of innovative experiences in science and technology in developing countries that have been successfully implemented and have directly benefited the quality of life in the South. In cooperation with the United Nations Development Programme's Special Unit for Technical Cooperation among Developing Countries (SU/TCDC), TWNSO recently published a volume highlighting examples of successful initiatives in science and technology in the South. Titled *Sharing Innovative Experiences*, the volume, which contains 29 case studies from some 15 nations in the developing world, complements efforts to create scientific centres of excellence. The centres have been designed to nurture home-grown brain power for progress; the case studies offer proof of how science has been put to work for the benefit of people — providing ground truth that science serves as an indispensable tool when tailored to meet the needs of the population. The next collection of case studies will focus on the use of medicinal and indigenous plants for sustainable development in the South. Work on this volume, which involves 15 centres of excellence, began in 1999. Centres participating in these projects are equipped with modern communication systems to facilitate the sharing of knowledge and best practices.

The *fourth element* in this strategy is to encourage scientific leaders in the South to offer independent, authoritative opinions to decision makers on issues of critical importance. Such issues include the potential impacts of advances in electronic communications, biotechnology, alternative energies, resource conservation and new materials. This goal can be realized by assembling interdisciplinary panels of experts that include the South's most prominent researchers in the natural and social sciences. Such independent, scientifically based and timely advice originating from scientific leaders in the South should prove of great benefit to national governments, regional and interregional organizations and regional development banks. Indeed, linking scientific expertise to the financial resources and know-how found in the developing world's development banks might provide an enduring framework for sustainable development in the South.

The policy debate on the application of biotechnology to genetically modified (GM) plants, which is currently taking place both within the South and between the South and North, would be greatly enhanced by an in-depth authoritative study prepared by scientific experts in developing countries. Citizens and decision makers in the South need to know more about recent trends in research activities, field trials and the commercialization of GM crops to enable them to devise appropriate policies, both for preserving their genetic resources and for capitalizing on this new technology when appropriate.

NEED FOR NORTH-SOUTH PARTNERSHIPS

As mentioned above, the capacity to generate new scientific and technologi-

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cal knowledge is concentrated in the science-rich countries of the North and is largely utilized to address the basic and material needs of these countries. The fact is that not much of this new knowledge has been used to address the critical problems of poor countries. As Sachs so aptly puts it: "All the rich-country research on rich-country ailments, such as cardiovascular diseases and cancer, will not solve the problems of malaria. Nor will the biotechnology advances for temperate-zone crops easily transfer to the conditions of tropical agriculture... rich and poor countries should direct their urgent attention to the mobilization of science and technology for poor country problems." (Sachs, 1999, p. 18.)

One of the most successful examples of North-South partnerships in science and technology involves the creation of a network of centres of excellence focusing on issues related to tropical agriculture. The system, sponsored by the Consultative Group on International Agricultural Research (CGIAR) since 1971, currently includes 16 international, independent and multidisciplinary institutions located in developing countries. By introducing new plant varieties and cultivation methods, the system sparked the "green revolution" in Asia and Latin America, which doubled global production of cereal crops between 1970 and 1990. The CGIAR system, which helped to combat hunger in large parts of the developing world, is now being challenged by the development and application of modern agricultural biotechnologies. These new tools complement traditional plant-breeding programmes by extending GM technologies to such crops as bananas, sorghum, cassava and potatoes, that are critical sources of food and income for many poor countries in Africa and Asia. CGIAR has begun to guide developing countries in the current global debate over GM crops. Last year, for instance, it called on developing countries to boycott the "terminator" gene technology introduced by Monsanto. The campaign succeeded in forcing Monsanto to abandon the programme.

Successful operation of the CGIAR system is based largely on the "centres of excellence" model framed by a clear mandate and a mission-oriented strategy. Because the centres are international in scope, local politics have not disrupted the system. Thus far, CGIAR has succeeded in generating stable funding from a large number of international aid agencies. This model needs to be replicated in other fields of critical importance to the developing world, including tropical diseases, information technology, biotechnology and renewable energies.

Another important model of North-South partnerships is based on the creation of networks to facilitate the mobilization of world-wide scientific expertise for addressing issues of global concern. An excellent example of this network approach is the programme for Research and Training in Tropical Diseases (TOR), launched by the World Health Organization (WHO) in 1974, to deal with major diseases endemic to tropical countries. With support from several international funding agencies and pharmaceutical companies, WHO also recently launched two major international programmes in tropical diseases designed to promote North-South collaboration. The first is the Roll Back Malaria programme. Begun in 1998, this programme, which is supported by 12 Japanese pharmaceutical companies, has sought to devise a global strategy for controlling malaria. The second is the Global Alliance for Vaccines and Immunization (GAVI). Begun in 1999, this initiative, supported by the Gates Foundation, World Bank and UNICEF, is designed to reverse the upswing in preventable diseases by making vaccinations readily available for children living in poor countries. Other important networks that have been established under such international organizations as the United Nations Educational, Scientific and Cultural Organization (UNESCO); the International Council for Science (ICS) and the World Meteorological Organization (WMO). Their networks include the World Climate Research Programme (WCRP), Man and Biosphere Programme (MAB), International Geosphere-Biosphere Programme (IGBP), and International Research Programme on the Structure and Function of Biological Diversity (DIVERSITAS). All of these efforts showcase the important role that UN-affiliated and other well-established international organizations play in global efforts to address critical public health and environmental issues. Such efforts have been handicapped in recent years by the chronic budget crises faced by the UN in particular and international organizations more generally.

North-South partnerships can be of great benefit to South-South cooperation strategies when such partnerships help build and maintain local capacities and excellence in science and technology. The development of Brazil's space programme and satellite technology offers an excellent example of this approach. In 1961, Brazil created a National Space Commission to develop satellite technology. Some 30 years later, in 1993, with assistance from a private US space firm, Brazil launched its first resource-data collecting satellite from Kennedy Space Center in Florida. Since then, Brazil has pursued two interrelated space initiatives: the Brazilian Space Mission (MECB) and the China-Brazil Earth Resources Satellites programme (CBERS). These initiatives, which now employ about 1000 scientists and engineers and 2000 technicians, use satellite technology to address down-to-earth concerns: changes in temperature, humidity and carbon dioxide concentrations in the atmosphere and real-time data on alterations in soil and water quality. Equally important, the information gathered from these satellites has been shared with scientists in other developing countries through some 300 Earth-data collecting platforms in Brazil and neighbouring countries. Brazil has also offered African nations access to the data through UNESCO.

Brazil's evolving space programme is a prime example of how North-South cooperation can be used to foster South-South cooperation. The effort began with the training of young Brazilian scientists and technicians largely in US universities and research laboratories. The programme's initial steps took place with the direct help of private firms and public institutions in the West: Brazil's first satellite was launched from the United States with a US rocket. The knowledge and know-how that Brazilian space scientists and technologists have acquired is now being put to use to help nations throughout the developing world examine critical environmental problems. At the same time, the initiative has raised Brazil's overall scientific skills and facilities. Today, a cooperative partnership with China has set the stage for even more rapid advances in satellite earth observing, data collection and communication in the future. All of this carries the promise of allowing researchers in the South to become true partners on projects devoted to global scientific issues. Such involvement could prove instrumental in 'southernizing' the North's scientific agenda. Research efforts could, as a result, be tied more closely to critical global issues as defined in part by input from scientists in the developing world. Ultimately, the entire global scientific community — both in the North and the South — would reap the benefits likely to accrue from using scientific data and knowledge to solve real problems faced by real people, especially the two-thirds of the world's population living in the developing world.

CONCLUSIONS

The greatest challenges facing the developing world in this era of globalization are how to build and sustain its own capacity in modern science and technology, and how to jointly mobilize and direct that capacity to address the critical problems facing large parts of the South. Those problems include shortages of food, energy, and water, inadequate communication and transportation systems, persistent threats to public health posed by environmental degradation and the spread of tropical diseases, and the problem of poverty itself. Systematically addressing such concerns will require coordinated and determined action by governments, private businesses and academia in the South defined by strategies for South-South cooperation.

The agenda for South-South cooperation outlined above would call on the South's best scientists and scientific institutions to join forces to direct their talent and expertise to address the South's problems. To facilitate implementation of this agenda, a strong case for supporting the development of science and technology in the South should be made by: (1) providing concrete examples of successful experiences in the application of science and technology to basic human needs in the South; and (2) creating platforms both for research institutions and individual scientists and technologists in the South to interface directly with the ministries of planning and finance — the most powerful decision-making bodies, when it comes to the allocation of financial resources.

Strong political will backed by firm financial commitments are essential ingredients for successful implementation of the strategies outlined above. The key financial institutions that should support such South-South institutions are the three regional development banks in Africa, Asia and Latin America. In collaboration with the World Bank and UNDP, these three institutions may propose the establishment of a special fund to support these strategies and other initiatives, aimed at lifting science and technology in the developing world to a level that will enable it to address the critical developmental challenges facing the South and indeed the entire world.

All of this means that South-South cooperation holds the key to science-based sustainable development in the developing world. This cooperation, however, must be directed towards two critical goals: (1) enhancing the capacity of developing countries, particularly the least developed counties, to fully embrace science and technology; and (2) devising science and technology initiatives that seek to address — indeed solve — everyday problems.

The level of investment that the developed world, particularly the United States, has made in science and technology over the past decade — for example, in information technologies, biotechnology and material science — poses a daunting challenge to the countries of the South. The bountiful fruits of these investments, which have been harvested largely in the North, suggest that developing countries, with their meager budgets and resources, may never be able to match the scientific and technological prowess of developed countries. The increasing privatization of scientific research only compounds the problem.

But it is also important to emphasize that recent developments in science and technology present opportunities as well as challenges. In fact, the stage may now be set for unprecedented opportunities for the rapid advance of scientific know-how and technological applications. That is because the same forces which are responsible for the increasing gap between the North and South may also serve as the building blocks for a more harmonious and equitable future. If the South can learn to take advantage of the new information technologies; if the potential benefits of biotechnology are applied to the developing world's indigenous resources for the benefit of its

> ***The South has now reached a stage of scientific and technical development where it is possible — indeed imperative — for developing nations to learn from one another.***

indigenous populations; if advances in resource conservation and energy production are integrated into national development programmes; if discoveries in material science find their way into domestic production processes, then the future of the South is likely to be marked by economic progress.

All of these are huge "ifs", and success is by no means certain. But the South has now reached a stage of scientific and technical development where it is possible — indeed imperative — for developing nations to learn from one another. Successful steps in South-South cooperation, in short, provide useful markers for additional success in the future. And that may be best news of all. The more deeply entrenched South-South cooperation becomes, the more likely developing countries will be able to chart their own destinies. □

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Change of Paradigm in Science & Technology Policy

by CARLOTA PEREZ

The world-wide technological revolution has changed not only the rules for scientific and economic behavior, but also the game itself. Therefore, the way developing countries deal with science and technology needs more than reassessing — it needs fundamental rethinking. Carlotta Perez, an international consultant, discusses concepts and attitudes that need to change in order to take full advantage of the new conditions.

WE ALL KNOW we are in the midst of a change of paradigm, in the midst of a change in the rules and principles for effective techno-economic behaviour. We have been living through a deep modification of the "common sense" for achieving best practice. This change affects every organization, from business to government, and every level, from international organizations to the smallest local NGO.

We know this has been brought about by the information technology revolution. Yet the transformation goes far beyond the power of computers and Internet; it entails the adoption of organizational models that are adequate for taking advantage of that potential; it involves the modernization of both the structures and the forms of operation of every organization in any field of activity. It implies moving:

- From rigid mass production to flexible networks
- From centralized pyramids to decentralized adaptable structures
- From people as human resources to people as human capital

And, in the developing world:

- From protected subsidized industrialization to competitive production in a globalized world

We all know that and we also understand both the difficulties of such a transformation and the opportunities it opens, both the uncertainty involved and the inexorable nature of those trends. They are precisely the direct consequence of the technological revolution that emerged in the 1970s and is fully taking root as the main productive potential into the 21st Century.

The questions we need to ask are:

- What does this transformation mean when we look at science and technology in the developing world?
- What does it mean when we examine South-South cooperation in S&T and want to achieve concrete and meaningful results?

It simply means that, just as managers of firms have had to do, painful as it may have been, the science and technology community needs to revise, redefine, reassess and rethink every single thing we thought about S&T in the 1960s and 1970s. We must recognize that the body of knowledge and experience about S&T that we now have was shaped by the conditions of mass production technologies, as well as by the import substitution model of industrialization.

In my view we are far behind in the necessary reassessment. This partly explains the meager results. Without that rethinking, our actions can miss the target. Without that, our chances for success are minimal.

One of our basic tasks is to redefine the field of activity by widening the scope of what we call technology. The changes are quite dramatic and fundamental (see table 1).

Further still, there is a difference between the old and the new paradigm that has far-reaching consequences for developing countries. Because mass production required very high volumes of identical products for maximum profitability, the whole world was pushed into homogeneous patterns of production and consumption. Cultural differences and identities were ironed out in the melting pot of the "American way of life." So transfer of technology was often seen as imposed from abroad and, even when welcome, was in practice judged inadequate.

This situation could change dramatically. The flexible technologies of the new paradigm are essentially adaptable and can cater to diversity. The world is far from reaping the full fruits of this characteristic because the habits of mass production are still too deeply ingrained. This has happened with each paradigm change. The first automobiles looked likes carriages without horses and we are still measuring engines in "horsepower." But, as we learn to use the new potential, we will discover that appropriate technology is possible, profitable and natural in this paradigm.

Those are only a few of the many fundamental changes in outlook that we need to make in order to guarantee that we can take proper advantage of the opportunities offered by this paradigm.

But the essential thing we must be

Table 1—SCIENCE AND TECHNOLOGY PARADIGMS

	Previous paradigm (1950s-70s)	Present paradigm (from 1980s)
Focus of technological efforts	Mainly manufacturing industry (to escape from raw materials dependency)	All wealth-producing activities, from raw materials to information and social services
Type of technology pursued	Tangible technology (embodied in equipment and products, while human know-how was about using them)	Tangible and intangible technologies (not only software and design, but also organizational know-how)
Aim of technological development	Radical innovations, patentable products which can be "sold" and/or processes that can be "packaged"	Radical and incremental innovations. Those that can be sold and those that imply constant modifications, adaptations and improvements (which make a difference in results, but cannot be sold as such).
Where and by whom is technology developed	In R&D departments inside firms or in university institutes by scientists, engineers and technologists	In firms, in institutes and between them, done by all members of the organization and by all members of society
What is innovation in society	Innovation is a "job" in a specialized organization	Innovativeness is the way of living and working in the Knowledge Society

clear about is the need to reexamine our ideas and our experience:

- What worked yesterday will probably not work today.
- What failed yesterday could work tomorrow.

Now I would like to advance some ideas about what, in my own view, are the ways forward, the concepts and attitudes we need to change in order to take full advantage of the new conditions:

1. Break the "marriage of convenience" between science and technology

In import-substitution times, technological activities had to take refuge inside the scientific laboratories. Mature technologies from the North were in no need of local innovation. So there was no real demand for technology, and it had to "marry" science and adopt its behavior. Now, technology is needed side by side with every production activity and with every social service. Now it must come out from the temples of science and fully join the action.

We need to bring technology in full contact with production. We need it to become technological development and engineering so we can really change the quality and productivity of our productive activities. What we don't need is to have technology working in isolation, with the methods, criteria and pace that characterize, rightfully, the production of scientific knowledge.

But we also need scientific and technological research (and it is unreasonable to pretend that scientific projects should respond to demands from industry in developing countries). Local science and local scientists are our dynamic link with the universal pool of knowledge.

2. *Widen the scope of "technology" to include organizational, managerial and social capabilities and know-how*

Scientific, technical and social disciplines need to be put to the task of problem-solving both in directly wealth-creating activities and in those that are geared to enhancing the quality of life of the population. If firms need to be world competitive, governments and social services need to modernize even more urgently, to deliver management and social well-being with maximum efficiency and effectiveness.

Unless we believe in the "trickle-down effect" (and are also willing to wait for it to slowly work its way through the system) there is no reason why publicly funded technological development efforts should concentrate on competitive activities only. The whole range needs to be covered, though probably by different people.

3. *Expand the range of actors in producing innovation*

In accordance with the new paradigm, continuous improvement needs to become the way of working for all, from the top managers and specialists to every single worker, and it needs to become a way of approaching activities, from the production world right into the community and the home.

Learning to analyze processes, to identify ways of improving them, reducing efforts and costs, adapting them to specific conditions and even changing them radically is necessary for all citizens. Educational reform should include the introduction of such habits as a key component, and so should job training programs. But the almost "cultural" change that this implies for all those that are now in industry or government is very deep and very necessary.

A huge social contribution could be made by the S&T community by becoming the champions of generalized innovativeness in society.

4. Stop trying to build a "bridge" between university and industry, and instead take the dividing river away

We need to learn to live in constant interaction between technology users and producers. We need to open universities to all social actors and move researchers and engineers out into the field, out where their work is used. We are coming from long decades of mutual distrust. Researchers looked down on "business people who are only interested in money," and business people considered researchers "impractical dreamers who don't know the real world." These attitudes resulted in a lack of common language between the two worlds. We now need to build a platform of mutual trust and respect, which can only result from frequent collaboration, probably beginning with small simple things and growing from there.

5. Clearly distinguish four areas of action which are all equally crucial:

- Scientific and technological research understood as the creation of knowledge capital for today and tomorrow;
- Technological development for world competitiveness geared to modernizing the export sectors and their support network, involving incremental and radical innovations (with full consciousness of the international knowledge frontier);
- Technological development for improving the general wealth-creating capacity of the country, the regions, industries and firms (particularly small and medium enterprises). This includes educational reform, technical infrastructure, development of consultancy, financial and technical services (from information to maintenance), and so on;
- Technology for the people geared to enhancing the quality of life of each portion of the population on each portion of the territory. It would involve the development and implementation of appropriate technology, the enhancement of human capital with the specific needs of each particular locality, and stimulating general innovativeness to solve local problems.

We need to move strongly on all four fronts. Yet, each of those four distinct areas of action must be approached differently. Each requires:

- Different criteria of priority
- Different ways of funding and different sources
- Different actors and ways of organizing
- Different mechanisms for promotion and conditions for diffusion

(for instance, scientific research and technology for the people should be vastly disseminated, while technology for competitiveness should be patented and closely guarded)

- Different ways of measuring results

What works or fails in one front, does not necessarily work or fail in another. As with everything else in this paradigm, segmentation, diversity and adaptability are essential for effectiveness and for successful efforts.

So, let us segment and diversify our efforts in South-South cooperation for science and technology. Let us differentiate the goals in research, development, engineering and organizational modernization, and let us gear them carefully to the various objectives to pursue.

Let us also adapt them to the various realities of the developing world, between and within our countries. This was not easy to do in the mass production world. It is not easy either in the flexible networks world we are now building, but it is certainly feasible. Let us make sure we don't miss the opportunity. □

How Can South-South Cooperation Contribute to a Knowledge-based Development Strategy?

by CLIVE THOMAS

"The contribution of technical knowledge to productivity and economic growth over a wide range of countries exceeds that of all other productive factors," writes Clive Thomas, Director, Institute of Development Studies, University of Guyana. But what can countries of the South do to implant knowledge building as the driving force for constant innovation and successful competition in the global context? Here is a realistic discussion and weighing of some needed practical strategies and support policies.

ONE OF THE MOST TIMELY and important initiatives which can be pursued at this juncture is South-South cooperation in science and technology capacity building in the context of a knowledge-based development strategy. Such cooperation can both contribute to the economic growth and development of the South, and promote international relations among countries with widely different social systems, economic capacities, and levels of welfare. Despite obstacles, there is no reason why South-South self-reliance and international cooperation should not complement each other in the pursuit of a knowledge-based development strategy.

In a knowledge-based economy, the prevailing cultural, social, economic, political, and institutional conditions favour the generation and dissemination of knowledge and its systematic interaction with technological innovation. Together these linked factors provide the foundations for economic growth in a highly competitive global economy. This typifies the situation in several developed economies. Development strategies in the South which are based on building knowledge and fostering innovation have evoked much international support among economists. But why has this particular consensus arisen?

At least three sets of empirical data have largely contributed to it:

- A very large body of data on economic measurement and growth accounting shows that the contribution of technical knowledge to productivity, economic growth, and prosperity over a wide range of countries exceeds that of all other productive factors.
- Another set of data found that education, training, and systematic and timely incorporation of knowledge and R&D results into production/distribution processes make outstanding contributions to growth. These data come from careful examination of the achievements of the "Asian tigers" and other exceptional performers among the developing countries.
- The third set of data derives from experiences during the current wave of globalization and liberalization. These reveal that success in world markets today requires competitiveness in *both* price and innovation; in earlier periods, price led the way in determining enterprise and national competitiveness in international markets. Unless both occur at the same time, a country is unlikely to be able to sustain prosperity and market shares.

If these data largely explain the reason for the broad consensus, the challenge that remains is to determine what countries should do practically in order to promote a knowledge-based development strategy. How can they move from rhetorical support to successful implementation, and what roles can South-South cooperation play?

Success in world markets today requires competitiveness in **both** ***price and innovation. Unless both occur at the same time, a country is unlikely to be able to sustain prosperity and market shares.***

Two tasks need attention here: strategizing and policy-making. The first task is to develop strategies for (1) South-South relations, (2) South-South cooperation as a particular form of these relations, and (3) the process of innovation. The second task is to devise complementary and supportive policies which will be required if South-South cooperation in science and technology is to contribute successfully to a knowledge-based development strategy.

STRATEGIZING

South-South relations

South-South cooperation in one form or another has been with us since the end of World War II. What we have to guard against most is an impractical, idealist view of potential South-South cooperation. Past experiences reveal that, despite strong imperatives in favour of cooperative solutions among countries of the South, these have not been taken advantage of sufficiently. In part this has been due to growing divisions and weaknesses within an increasingly heterogeneous South. It has also been due in large measure to the prevailing structures of global economic and political relations, which do not readily encourage horizontal South-South cooperation.

Reinforcing this at present are severe constraints on the scope of South-South cooperation arising from legally binding and enforceable obligations which have been entered into comparatively recently among many countries of the South and global intergovernmental bodies. Often, such obligations either take precedence over South-South cooperation, or set the parameters within which such cooperation can be effectively promoted. Many of these obligations are in important areas of national economic policy, such as macroeconomic management, external trade in goods and services, environmental regulations, and inward and outward flows of capital and finance.

Two examples illustrate the scope of this concern. First, a number of environmental obligations and agreements have recently become operative. Under these, countries of the South are now unable to pursue the growth path followed by developed economies, insofar as it was based on their avoiding the external costs of environmentally damaging and natural-resource-wasteful policies. Second, in similar vein, recent agreements on intellectual property rights preclude the strategy of "reverse engineering" in building national technological capacity. That strategy was successfully pursued by almost all the newly industrialized countries (NICs) until as recently as the 1980s. The examples show that such obligations can reasonably be expected to play a major role in determining the pace of domestic liberalization that the economies of the South can set themselves, as well as the extent of their participation in the process of globalization. The inescapable conclusion is that, to be

The prevailing structures of global economic and political relations do not readily encourage horizontal South-South cooperation.

effective, proposals for South-South cooperation in science and technology have to be explicitly strategized with these realities to the fore.

As if the circumstances identified so far were not sufficiently constraining, more limiting factors are emerging at the global level which will affect the prospects for South-South cooperation in science and technology. The growing number of North-South bilateral arrangements frequently cover strategic national interests of both sets of countries, particularly in political, security, and economic areas, and set very binding parameters. Also, in the past two decades and in a current wave, regionalization has embraced a number of countries from both North and South, creating comprehensive obligations and responsibilities governing trade, investment and production. A realistic assessment of the prospects for South-South cooperation in science and technology cannot ignore these agreements. It would be impossible to pursue South-South cooperation separately and distinctly from these regional integration schemes.

Additionally, a growing body of information suggests that much apparent South-South cooperation in production, trade and R&D actually results from strategies of globalization being pursued by major TNCs in the North (Ernst, 1994). To that extent, some of what is being represented today as ongoing South-South cooperation may in fact be driven more by the strategic concerns of TNCs based in North than the South's own development priorities.

Finally, in South-South relations, despite exceptions, as in the case of petroleum, there is a considerable amount of "beggar-thy-neighbour" South-South competition in global trade. Such competition is mutually self-destructive and encourages the very opposite of cooperation. This tendency is observed primarily in trade in traditional primary products at the lower end of the technological scale, where real prices relative to other commodities have deteriorated. This has weakened rather than strengthened the drive towards South-South cooperation in commodity pricing. This is in stark contrast to the 1960s and 1970s, when these countries came together to promote the call for a New International Economic Order which, among other things, would have afforded stabilization measures for primary commodities.

South-South cooperation arrangements

Traditional forms of South-South cooperation practiced since the 1960s, including schemes for regional integration, embrace certain key features (Thomas, 1994):

- From inception they were based on common external protection against third countries. External protection was the principal device for promoting intraregional trade and displacing third country imports into the region. The emphasis was on trade diversion as against trade creation.

- At the same time, regional import substitution was encouraged as a replacement/extension for national import substitution, which by then was being stymied by the typically small national markets in developing countries. Product specialization in pursuit of regional import substitution was typically buttressed by a number of intergovernmental cooperation protocols, which often conferred subsidies, tax exemptions and other such benefits to firms producing under this arrangement.
- Third, these arrangements tended to overemphasize traditional industrialization/manufacturing as the leading factors in economic growth and to underemphasize science and technology capacity building, innovation, and modern services. Indeed, when introduced, most of these schemes were conceived explicitly or implicitly as alternatives to North-South relations, and were therefore premised on a zero-sum model of economic relations between countries.

This approach might have been useful in the 1960s and early 1970s, but by the 1980s such regional arrangements were encountering many difficulties. It was soon realized that, to be successful, cooperation arrangements need to embody newer principles and features that reflect the wealth-creating process in the new global context. The new policy orientation is to emphasize and support the emergence of new actors and new processes in cooperation arrangements among countries. No longer is there principal reliance on intergovernmental negotiations, protocols and agreements as before. New actors like the private business sector and civil society, and new processes like private markets are expected to take the lead. It is also recognized that for economic processes to be dynamically successful and innovative, they should be stakeholder-driven, with emphasis on networking, mutual capacity building, and knowledge development among regional stakeholders. So far, arrangements based on this approach are far more likely to be innovative, flexible and capable of coping with the competitive pressures which are integral to the process of glob-

Cooperation arrangements need to reflect the wealth-creating process in the new global context by including new actors like the private sector and civil society, new processes like private markets taking the lead, and the dynamism of networking and knowledge development among regional stakeholders.

alization. Finally, this new policy orientation is far more likely to deliberately pursue and embrace cooperation at the level of the domestic sectors of the participating economies; promote development of extraregional exports along nontraditional lines; and make better allowance for pooling costs and creating the critical mass required to reduce uncertainty and orient enterprises more towards user needs and requirements.

If this sort of approach to economic cooperation is accepted, then strategies for South-South cooperation in science and technology can follow no single a priori organizational form in all circumstances, all situations, and at all times. Different practical arrangements will have to complement each other in a flexible network of South-South cooperation. Also, in view of the extent of globalization commitments many countries of the South have already entered, new South-South cooperative arrangements would have to be explicitly designed to complement existing and future North-South relations, in a positive sum model of international relations.

In devising South-South cooperative arrangements, one also has to keep in mind that the North like the South, is not a homogeneous grouping. While compelling circumstances shape North-North cooperation, many of these are based on market forces, which foster competitive relations between countries and enterprises. By their very nature, therefore, these can be expected to yield opportunities for the South. Already Northern NGOs have at times shared common interests with the South on science and technology issues, including capacity building in the South, in defence of civil society interests in the North. Also, there are important political and cultural differences within the North — between Europe, Japan and North America — regarding South-South cooperation and capacity building, and these can have significant bearing on the outcome.

Finally, the heterogeneity of the South indicates the existence of significant "knowledge gaps" and "technology gaps" within the South. By their very nature, such gaps represent both constraints on and opportunities for South-South cooperation. They are constraints in the sense that within the South best-practice technology may not always be available, and opportunities since development experiences may be broadly similar.

Knowledge, science and technology

Successful cooperation in science and technology has to be founded on a clear understanding of what these concepts represent. The contemporary scientific and technological revolution is unlike that of previous periods and has many distinguishing characteristics.

First, modern-day innovation which drives the competitive process is becoming more and more variegated, complex, and comprehensive in scope. Increasingly innovation seems to involve the upgrading of all technologies, affecting all sectors and wealth-creating activities in society. The process of innovation also embodies a wide array of concerns, including:

- the time, cost and risks attached to its promotion;
- availability of the requisite human resources and skills to make it possible;
- the regulatory and incentive framework that supports it;
- the extent of openness and accessibility to information and data practised in society;
- the cumulative impact of "learning-by-doing" and "learning from past success and failures";
- the pace of globalization and the interdependence and competition this generates;
- the relations between actors in the process (both from the point of view of the common sense of cooperation and the stimulus of competition);
- the impact of environment/ ecology; and the random effects of the "serendipity" factor.

With this scope, innovation has led also to the intrinsic broadening of what is represented by knowledge. From an economic standpoint, knowledge can no longer be confined to traditional R&D activities. Other economic areas such as marketing, maintenance management, environmental sustainability, engineering, design, organization of the work process, enterprise management, and indeed the very concept of enterprise itself have become involved in the process of knowledge creation and application.

Second, the current scientific and technological revolution has continued to intensify. Of course, it became painfully evident by the mid 1990s that decades of macroeconomic stabilization in the South had failed to yield an automatic, market-driven dynamization of these economies, as anticipated. This outcome led to the call for additional measures, partly contributing to the emphasis now being placed on knowledge-based development policies.

Third, the rapid growth of the global economy during recent decades has been accompanied by widening North-South gaps in all key economic indicators: income, wealth, production, consumption, investment, savings, and trade. Unfortunately, nowhere are the gaps wider than in science, technology and knowledge. The North-South gap in scientific and technological capacity is widening at a faster rate, and "catch-up" has become an even more distant prospect than before.

Fourth, the scientific and technological revolution has led to major organizational changes in most endeavours. In place of traditional hierarchies and rigid specialization, networks and clusters of firms and institutions are now preferred. The evidence is that this enhances competitiveness, mainly through linking technologies across sectors and generating mutual benefits for participants through shared knowledge in specially created "open" systems. These organizational changes have become so widespread as to blur the traditional distinction between the competitiveness of nations and the competitiveness of firms/enterprises. However, one caution is that the openness of these newly emerging networks and clusters is constrained. They usually seek to restrain new entrants, outcompete those outside the network, and deter participants from exiting the network. On the one hand they enhance competitiveness, at the same time promoting monopoly/oligopoly. The end result could well be the continuing concentration of scientific and technological capacity and innovation in a few transnational enterprises.

Fifth, as the scientific and technological revolution has proceeded, several factors promoting South-South cooperation in science and technology have emerged. The twin processes of globalization and liberalization which this revolution drives emphasize price and innovation competitiveness as the bases for countries and enterprises to be successful. Given the capacity limitation of the South in science and technology, cooperation invariably emerges as one way of enhancing individual firm and country capacity and competitiveness.

Sixth, the sheer scale and scope of some of the newly emerging technologies create their own urgencies. Thus, the progressive shift from raw material-intensive to information-intensive technologies has been disadvantaging the South and reducing the value of some of its natural resource advantages in the global economy. Similarly, many problems requiring technical solutions are becoming increasingly multicountry if not global in scope, especially in the areas of the environment and ecology, underlining the need for cooperative approaches.

Finally, the increasingly complex linkages between science and technological application, and between R&D and innovation, mean that large financial and other resources are required for successful commercialization of inventions. In market-based societies, the wealth-creating process depends on these resources being available in the required amounts. Most developing countries have a dearth of such resources, and so cooperation often emerges as one way of modifying its adverse impact.

SUPPORT POLICIES

South-South cooperation in science and technology is not, and should never be pursued as, a stand-alone problem for science and technology. Broad policies in support of such cooperation are necessary for it to become operational. There is a real risk of viewing science, technology and innovation as forces on their own, separate and apart from the people, institutions, and organizations through which they are created and used. In the pursuit of South-South cooperation such technological determinism has to be avoided at all costs.

Rather, we must shape the supportive policies, institutional frameworks and organizational changes required to shape the outcomes we desire.

Present standards and expectations of governance should lead us to reject the earlier models based on top-down command structures designed and directed by governments and/or international bureaucracies. Modalities and mechanisms have to be "invented" to advance the cause of South-South cooperation in the area of science, technology, and innovation in the present age. There are no available, ready-made, "off-the-shelf" solutions waiting to be applied, and no general, across-the-board, one-size-fits-all solutions for South-South cooperation. However, some general principles may be used to guide strategies and policies and to demonstrate ways these can coexist and complement region-specific initiatives.

> ***There is a real risk of viewing science, technology and innovation as forces on their own, separate and apart from the people, institutions, and organizations through which they are created and used.***

The importance of one support policy — seeking to learn from past experiences — should not be underestimated, even though today there is some scepticism about its usefulness as an aid to problem solving. In the past, considerable efforts were made by the international community to promote one-way technology transfer North-South and science and technology planning in the South. Despite significant resource inputs, these endeavours achieved little success. Likewise, a number of South-South initiatives for cooperation in science and technology supported by international organizations and governments in the North over the past 50 years also declined. In large measure this decline reflects the reduced role now exercised by governments and international organizations as globalization has proceeded and private actors have come to occupy centrefield. This body of practice might have much to teach us about why policies fail.

Secondly, no strategy for South-South cooperation in science and technology would be practical unless it builds on existing programs of South-South cooperation, as well as national and regional capacities in the South. An assessment of these capacities would be of immense value, particularly if it draws lessons from different development contexts. Ideally the assessment should focus on 1) the interaction between participants/processes/institution/sectors;
2) the way problems arising from technology were dealt with; and 3) the opportunities/constraints which still exist for accessing and producing new technologies. Overall the assessment should establish how to promote mutual

benefit in South-South cooperation, in contrast to the traditional one-way technology transfer from North to South pursued in the 1970s and 1980s. Unfortunately, we do not even have a full inventory of the number and type of South-South cooperative arrangements, let alone an assessment. The available information, though patchy, suggests more such arrangements may exist than is generally presumed — a few at the broad level of the South, and many more in little-known bilateral and regional arrangements. If true, there may well be opportunities to build further on capacities already achieved in the South and to link them together (Rath, 2000).

Unfortunately, we do not even have a full inventory of the number and type of South-South cooperative arrangements, let alone an assessment.

Third, there is also a growing body of research on the reform process in the South, examining under what conditions innovations in institution building and policy reform are likely to succeed. This knowledge should be brought to bear in an exercise designed to enhance South-South cooperation in science and technology. Already there are important hypotheses vindicated by this work, which could be helpful in strategizing South-South cooperation, including:

- The importance of metainstitutions and "the rules of the game" in determining success. (The latter exist, independently of both the issues of the moment and those that seemingly exercise power over them, in determining the environment for reform and major policy change.)
- The significance that should be attached to the particular political/economic "moment" at which major policy reform and institutional changes are attempted.
- The importance of listening to the views of interest groups/stakeholders, as these always affect the outcomes. This emphasizes the crucial role that advocacy and mobilization of support play in the process of policy reform and institutional building.
- When pursuing policy reform in one area, it is important to keep in mind linkages between it and the broader development context of the society. The evidence supports a multifocal (in contrast to a fragmented) and multisectoral (as against a sector-specific) view of technology, when assessing its opportunities and constraints. In other words, South-South cooperation in science and technology cooperation should not be promoted as an isolated endeavor, but be closely linked and coordinated with national development pro-

grammes and priorities.

- Social acceptance of the policy objective of a reform is a very important determinant of its eventual success. The hypothesis is that the concerns/expectations of the population in general and of those directly affected by reform are both crucial to the outcome (Graham *et al*, 1999).
- The incentive environment within which the proposed reform is pursued is critical to its success. Scientific and technological cooperation therefore cannot be treated in isolation from its successful commercialization.
- One hypothesis stresses the dangers of universalist solutions in technology. Solutions differ not only among countries, but even within countries and over time in the same country, as attitudes and values change.

In conclusion, whatever modalities of South-South cooperation in science and technology are eventually chosen, risk and uncertainty will always remain enormous. At the same time, the necessary involvement of new actors and processes in this endeavour places a high premium on commercialization, innovation, and entrepreneurship. Perhaps the best-known mechanism, which facilitates combining risk-taking and commercial sustainability, would be the establishment of a *South Venture Capital Fund*, dedicated to raising resources for R&D cooperation and the commercialization of the innovations that flow from it. While such a Fund would take risks, more important, it could be of strategic value in cementing the bridge between innovation and production for sale in competitive markets — one of the most formidable obstacles facing dynamic innovation and development in all environments. ☐

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SOME PRINCIPLES, CRITERIA AND PRIORITIES FOR

Knowledge Sharing in Science and Technology

by **JORGE AHUMADA-BARONA**

In the very complex world of science and technology, there are nevertheless some basic ideas about how to join forces across the South for the development and deployment of new knowledge for mutual economic and social benefit. The Director of the Tecnos Foundation in Bogota, Colombia, Jorge Ahumada-Barona, outlines a few suggested fundamentals.

ONLY RECENTLY has the real value of knowledge and the need for its appropriate management been recognized as the major factor in economic development. The main differences between poor and rich countries are not only in the magnitude of their capital, but also in the extent and depth of the knowledge available to them. Closing these gaps is not easy, especially due to the rapidly moving knowledge "frontier," and developing countries generally have a low capacity to create knowledge. What is needed is not striving to become a world economic power, but creating and adapting knowledge to attain sound economic performance and satisfactory social indicators, which is clearly easier said than done.

If they are to reduce these gaps, developing countries need to take three critical steps:

- ***Acquiring knowledge*** by transfer and adaptation of available knowledge worldwide, by creating new knowledge, or by building upon indigenous knowledge;
- ***Absorbing knowledge,*** which results from ensuring universal basic education, science and engineering education, and lifelong education;
- ***Communicating knowledge*** by making the new information and communication technologies available to the great majority of the population.

International research and development (R&D) produces findings which are useful for developing countries, but most knowledge that is important comes from the countries themselves. Information on policy developments taking place in one country can help others, and the outcomes of many projects can provide clues to causes of failures and successes which are useful to others. However, since it is beyond the capability of any one country to gather, evaluate and share this knowledge with others, this task should be a main responsibility of international institutions within and outside the United Nations system. The objective is to create and manage a system for amassing knowledge and making it suitable for further uses and adaptations. What should be shared is not only "hard scientific and technological know-how", but also the "soft technologies" involved in managing science and technology and their social implications.

Below are some established and new criteria for mechanisms of cooperation, programs and projects, exchange of information, education and training, all within the framework of knowledge sharing. Finally, some considerations on priorities and financial aspects are discussed.

PRINCIPLES CONCERNING THE MECHANISMS

The following should be the basic principles underlying a mechanism capable of efficiently accomplishing what South-South cooperation is intended to achieve.

- ***Absence of new bureaucratic authorities.*** No agencies or institutions should be created. Existing national and international institutions, ministries of science and technology, or similar organizations in each country should be responsible for conducting and coordinating the work.
- ***Increased participation of NGOs.*** These have shown in many instances their capacity for attaining cost-effective results, and thus should participate more in the process of S&T cooperation in their own right and complement government efforts.
- ***Flexibility, responsiveness and economy in operational management.*** Efforts should be made to limit regulations to a minimum and to maximize the effectiveness required for a highly technical operation.
- ***Utmost use of electronic communication methods.*** In this way, onsite meetings will be reserved for work relating to the implementation of cooperation projects.
- ***Benefiting from past and ongoing experience.*** Lessons from both successes and failures should be learned at regional, subregional and local levels, including those of private and public centers and institutions whose main objectives are cooperation.

CRITERIA CONCERNING PROGRAMS AND PROJECTS

In addition to logical criteria of concreteness, feasibility, sustainability, similarity of interests and relevance, the following are considered important in selecting programs and projects for cooperation in science and technology:

- ***Effectiveness:*** This criterion would determine whether cooperation between countries offers added advantages and is more effective than separate implementation. Advantages might include economies of scale, quicker and better results, complementary learning and capacity-building processes, and technology and knowledge transfer. This criterion applies, with changes, even when a sizeable difference in the development levels of participating countries leads to technical assistance rather than a cooperative project.
- ***Multinationality:*** This criterion would favor work on issues where research requires a larger critical mass. An example is certain aspects of biodiversity and other topics of mutual interest to countries with similar geographical or ecological circumstances, i.e. shared river basins or similar tropical ecosystems.
- ***Prior existence:*** A highly desirable and advantageous criterion is the prior existence and operation of projects similar to those proposed, so as to take advantage of what each has accomplished separately, mount a broader cooperative effort and obtain results faster.
- ***Follow-up and assessment*** should be designed into every joint endeavor so as to weigh progress and results in relation to attaining goals and learn lessons about program management.
- ***Prior agreement*** among scientists and administrators from countries interested in a cooperation program on whether it is justified and convenient to treat the proposed issue in a scientific way, which objectives, goals and activities are to be developed, how to distribute responsibilities, and what resources of various types are necessary.
- ***Participation of the North*** in a given South-South effort should not be discarded a priori. In many cases it can be convenient for financial reasons and even necessary on technical and scientific grounds. This participation should not be left to chance, but based on a systematic, organized, long-term interaction with the countries or communities involved.

CRITERIA CONCERNING EXCHANGE OF INFORMATION

For certain issues, it is critical and even imperative to exchange information with other countries at the same level of development. For example, the largest reservoirs of biodiversity — located in developing countries — are most in need of sustainable management; yet much of the national and global-level knowledge about this can be obtained only through extraordinary effort, even when industrialized nations are doing it. Unfortunately, developing countries generally have little installed capability to gather, assess and give added value to information for the sake of its circulation and use. In other instances, there is a large volume of information at the appropriate time and broken down to the required level, but exchange mechanisms are inadequate.

How to generate and direct information exchanges that will be more complete, efficient and sustained? The obvious first requirement is that countries must invest in building or reinforcing their capacity to gather, store, organize, evaluate and use their own information and knowledge. Parallel to these efforts, countries must gain access to a variety of mechanisms for exchanging information, especially those offering better cost-benefit ratios. The following are some recommended channels and methods:

- ***Use of the Internet*** to circulate and obtain information from Web pages and clearing-house mechanisms.
- ***Networking of specialized information centers*** to facilitate on-line consultation of their databases.
- ***Question-and-answer service*** to handle specific requests for information on a particular country.
- ***Encouragement of communication among specialists*** by creating directories, mailing lists, discussion groups and electronic bulletins on the Internet.
- ***Informal transfer of documents*** between scientists and specialists. Traditionally done through personal contacts at meetings or at a distance, it is now made easier by electronic means.
- ***General or specific bilateral agreements*** through which information is exchanged on topics of interest to each country.
- ***Concentrations on priority areas*** selected by participating countries for joint R&D projects or other activities.
- ***Exchange of knowledge about how to manage information systems,*** including about methods of information gathering and evaluation in selected areas of interest. There is also scope for technical assistance in this field.

PRIORITIES

It is imperative to establish priorities when dealing with the wide spectrum of needs for science and technology cooperation, especially since financial resources are limited. Operational decisions should be taken case by case, as countries are considering entering a partnership project or initiative.

However, looking across the board and interregionally at the opportunities

THE EXAMPLE OF BIODIVERSITY

Biodiversity and related fields involve an enormously complex range of phenomena. This makes it very difficult for scientists to understand and interpret many of the mutual relationships among components of our ecosystems and between these and the human environment.

Developing countries need to get ahead of the reeling pace of technological change associated with the use of biodiversity. To do this, they have to develop a critical mass of researchers and technologists who can study the basic issues and characterize, evaluate and use the resources of biodiversity. It is also essential to relate these studies and findings to the social, economic and cultural processes of the populations involved. Education and training on biodiversity needs to reach not only researchers, field-applications specialists and program managers, but also the public.

Below are some useful criteria to guide cooperative efforts concerning biodiversity, including related education and training:

- Give preference to topics related to ongoing projects and programs within the common interests of participating countries
- Pay attention to techniques, methodologies and technologies for expanding what countries know about their biodiversity, their limitations and potential
- Emphasize technologies that increase the added value of products and by-products of biodiversity
- Work in multicountry groups for holistic study of biodiversity factors, components and phenomena, for assessing cultural, ethical and other aspects, and for interchange of information.

and possibilities, it is possible to suggest a few areas of science and technology where it seems feasible and desirable to concentrate efforts. Proposed topics which are vertical in coverage are biotechnology, management of biodiversity (see box), and information-communication technologies. Horizontal topics are R&D management, knowledge management, science education, and science and technology policy.

FINANCIAL ASPECTS

It is often argued that the main obstacles for an effective South-South cooperation stem from the lack of funds and political interest by the countries themselves, a frequent preference for North-South interaction, the lack of technical and financial support by the industrialized countries, and the absence of a financial mechanism with global coverage.

To bypass or surmount these obstacles, the founding principles in a financial strategy for South-South cooperation should be that participating countries earmark resources for scientific and technological cooperation, and that programs and projects are based on the sharing of costs and benefits among participating countries.

As appropriate for different programs, funding would come from a combination of sources such as government budgets for R&D, government resources earmarked for bilateral cooperation, national and international nongovernmental organizations, and multilateral banks (global, regional and subregional). In some countries, an alternative source to explore is private risk capital. ☐

Some Priority Sectors and Specific Actions for South-South Science and Technology Cooperation

by **OUSMANE KANE**

Four main priority sectors and four types of practical action hold particular interest for developing regions needing to collaborate in science and technology, says Ousmane Kane, Executive Director of the African Regional Centre for Technology in Dakar, Senegal. But, he points out, growing technological protectionism and the predominance of multinational corporations in R&D make it difficult to mobilize necessary financial resources for this cooperation.

INTRODUCTION

Science and technology are the principal tools for bringing about the changes needed to meet humanity's ever expanding needs. They are also the principal elements of the new world order at the dawn of the 21st century. Progress in science and technology is dependent on the broad sharing of information and know-how. It is therefore essential to maintain the flow of exchanges of information or experiences on, for example, research methods and results, in order not only to promote the advancement and dissemination of knowledge, but also to improve relations and understanding among peoples.

For a number of reasons it is essential to promote scientific and technological cooperation at the subregional and international levels, especially among the countries of the South:

- The need to avoid duplication and optimize human, material and financial resources in situations of underdevelopment or economic crisis that are obstacles to the realization of national or regional scientific and technological potential;
- The similarity in environmental conditions that gives rise to general development problems that are similar in several sectors, such as agriculture, health, industry, etc.
- The globalization and liberalization of the world economy following the spectacular advances in new information and communication technologies, the trade agreements negotiated in the Uruguay Round and the World Trade Organization, and the emergence of large regional blocs or economic areas which are concerned first and foremost with their own interests;
- The large number of problems whose solution can be found only in a collective approach that mobilizes the entire international scientific community (for example, environmental and weather-related problems, natural disasters, or certain pandemics such as AIDS).

In order to promote cooperation in science and technology, a number of international institutions have been created which are part of the United Nations system, bilateral, part of non-governmental networks, or members of regional economic groupings. In addition, numerous initiatives have been taken at high-level international meetings, including the United Nations Conference on Technical Cooperation among Developing Countries (TCDC, Buenos Aires 1978), the United Nations Conference on Science and Technology for Development (UNCSTD, Vienna 1979), and, more recently, the World Conference on Science (Budapest, June 1999) organized by UNESCO. The High-level Forum on South-South Cooperation in Science and Technology (Seoul, February 2000), organized by the UNDP Special Unit for TCDC, is part of this new trend and has also created high hopes.

Numerous recommendations from such international meetings aimed to help build capacities and strengthen scientific and technological cooperation in the countries of the South. However, while the need for interregional or international cooperation in science and technology is generally recognized, results have fallen far short of expectations in light of the number of institutions created and initiatives taken. What are some of the main challenges that need to be overcome and some specific courses of action that might achieve better results?

PRINCIPAL CHALLENGES TO BE MET

The principal challenge to increased cooperation lies in the difficulty the international community faces in seek-

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ing to mobilize the necessary resources. This difficulty is compounded by two strong trends.

First, the emerging new world order, which is increasingly technological in nature and confers power (economic, military) and prestige on the technologically advanced nations, has led to fierce competition in technological invention and innovation. The latter then naturally become the object of strict protection, which takes precedence over cooperation.

Second, the wave of liberalization, state decontrol and privatization that is sweeping all regions of the world favours the emergence of private multinationals which are equipped with their own research centres or are financing public research teams under contract to them. These multinationals are, however, more concerned with their own profits than with solidarity or with the sharing of scientific and technological know-how.

> ***The emerging new world order has led to fierce competition in technological invention and innovation, and strict protection then takes precedence over cooperation.***

Other challenges that affect scientific and technological cooperation at the interregional and international levels include:

- The dynamism of micronationalisms, which is reflected in the pursuit of self-centred scientific and technological development policies that lead to the creation within each country of separate structures of higher education and research, even though these structures lack even the minimum resources needed for their proper functioning;
- The scientific and technological policies pursued in most States often prove in practice to be isolated initiatives that are genuinely integrated neither into national economic and social development plans, nor into bilateral and multilateral cooperation programmes;
- Linguistic and international travel (visas) barriers, the difficulty of travel or communication between the various countries, and the precarious nature of publishing facilities which, together with the lack of financial resources, lead inevitably to isolation;
- The absence of reliable data on the scientific and technological potential of most countries, duplication, overlapping of missions and lack of optimization and rational management of available resources which characterize most national, subregional and regional institutions, together with a failure to clearly define national objectives.

PROSPECTS AND POSSIBLE COURSES OF ACTION

The essential foundation is that the States concerned must be firm in their political will to rise to the challenges which have been identified. In exercise of that will, they need to adopt and pursue policies of openness to other regions of the developing world, readiness to promote regional and international South-South cooperation in science and technology, and solidarity in the joint strengthening of capacities and acquisition of appropriate technologies. That cooperation has to be based on a strategic medium- and long-term vision, on a choice of the priority sectors for such cooperation, and on agreed specific actions to be undertaken to achieve these objectives.

1. Priority sectors

There seem to be four main priority sectors in which all regions concerned have a particular interest in collaborating:

(a) Food and agriculture. The regions of the South share many similarities in their environmental and thermohygrometric conditions. The result is great similarity in agricultural and agrofood specializations, and common problems in the exploitation of different sectors. These regions would therefore benefit from effective collaboration in managing of water resources and the various production stages, as well as in the promotion of certain crops, with a view to increasing their productivity and functional, nutritional, organoleptic or commercial qualities.

(b) New and renewable energies. Most countries in Africa, Asia and Latin America face petroleum-import bills and suffer from widespread desertification as a result of the abusive use of wood as the principal fuel. There is room for active cooperation among these countries, aimed at satisfying their energy needs, while protecting their environment. Together they have very substantial potential for the development of new and renewable sources of energy, particularly solar energy, biomass, biogas and wind and water energy. They should work together on research to reduce investment costs and improve the application and maintenance of the technologies developed for these sources.

(c) Public health. Most regions of the South have a high incidence of tropical diseases and high mortality rates from them, including malaria, cholera, bilharziasis, and river blindness. Exchanges of experiences on early diagnosis, prophylactic and curative treatments for these endemic diseases would be mutually beneficial, with special attention to the development and protection of indigenous know-how, particularly in traditional medicines and pharmacopoeia.

(d) Information and communication. The new information and communication technologies play a preeminent role in enhancing performance in all sectors of economic, social and cultural activity. It requires a determined effort of mobilization to benefit from them across-the-board in the production of goods and services. Since these technologies are mainly conceived and produced in the countries of the North, their use carries the risk of maintaining and increasing the dependence of the South on these countries. Close South-South cooperation is therefore needed in order to strengthen their capacity to produce both software and hardware, and thereby reduce the gap between them and the countries of the North, while taking greater account of the specificity of their own needs.

2. Specific actions

There are four broad arenas for inter-regional cooperative action by the countries of the South to develop their scientific and technological potential in the priority sectors and in the light of the needs expressed by each region. The arenas for action are: establishment of a science and technology policy; human resources development; institutional capacity-building; and information exchanges.

In these efforts, it seems advisable to focus on regional centres for the promotion of science and technology in the respective regions. Promoted as true centres of excellence, they would not only help to limit the brain drain, but also benefit from the assistance of expatriate Southern experts from the diaspora working in the countries of the North. International consultative forums, including such international organizations as UNESCO, UNIDO, FAO, UNCTAD and EU-ACP, could also be used to strengthen South-South cooperation in science and technology.

(a) Science and technology policy. The main challenge will be to help countries develop a genuine science and technology policy that is itself closely integrated into the macroeconomic policy of each country. The policy should embody an effective strategy of technological innovation that is informed by a clear vision of the future. It should lead to the establishment of a structural and organizational framework for science and technology, the strengthening of training and research capacities and information systems, and the addition of value to technological innovations. It would also establish a dynamic partnership between governments, the research and development community, production enterprises, financing agencies and civil society. A permanent flow of exchanges of experiences could thus be organized, and relevant documents, particularly on case studies, could be produced and widely disseminated.

Women should play an active part in both the creation and use of technological packages.

(b) Human resource development. Science and technology training activities will be carried out within the framework of bilateral or multilateral exchange programmes between universities and research and development centres from the various regions of the South. Women should play an active part in both the creation and use of technological packages. The programmes would offer scholarships and training fellowships, and could be coordinated by the UNDP Special Unit for TCDC, in collaboration with regional institutions for the promotion of science and technology. The following types of activity could be considered:

- Formal academic training in basic scientific and technological disciplines.
- Advanced training or specialization courses. These could cover areas of general interest, such as the formulation, implementation and evaluation of scientific and technological policies; or focus on a specific area, such as research and development in a selected field (e.g. biotechnologies, new synthesis technologies, alternative energy, etc.).
- Seminars and training workshops to promote the exchange of ideas, experiences or information on specific themes of common interest.
- Study trips to gain firsthand knowledge of the experience of others, learn lessons and establish direct contacts, thereby creating new prospects or opportunities for cooperation.
- Teleconferences and distance teaching.

(c) Strengthening of institutional capacities. The regions of the South, particularly Africa, are severely limited in resources for science and technology and for research and development. The strengthening of their capacities could be accomplished by establishing regional centres of excellence for each of the priority sectors identified, with support from existing regional centres whose mandates would be expanded to include South-South cooperation in science and technology. Their principal programmes would focus on the following areas:

- Study and evaluation of the general technological needs of the region.
- Support for States in the formulation, application and evaluation of national strategies for technological innovation that are integrated into their macroeconomic and social policies. This would be done in such a way as to create effective partnerships between the State, the research and development community, and enterprises that produce goods and services, especially small and medium-sized enterprises.
- Coordination of specific inter-institutional South-South cooperation projects in research and development and advanced training, particularly in cutting-edge technologies.

- Development of a high-performance information system. It would include databases on institutions, experts both national and from the diaspora, technological alternatives, etc., that are tailored to the needs of researchers, economic operators, government authorities and civil society. It would also benefit from a wide range of publications (brochures, bulletins, etc.). The system would serve as a strategic tool for information, communication and technological monitoring aimed at providing information on both opportunities and threats worldwide.
- Support for the establishment of regional networks of associations, operating on an institutional, sectoral or corporate basis.
- Promotion and dissemination of the results of research through the establishment of pilot demonstration units and techno-enterprise incubators.
- Promotion, support, protection and valuation of traditional knowledge in order to better adapt it to modern-day imperatives and promotion of dialogue and cooperation between modern and traditional practitioners.
- Encouragement of invention and technological innovation in the region, including through the award of prizes and other incentives.
- Promotion of the transfer and acquisition of environmentally friendly technologies among the different regions, including through the provision of advisory services on technological choices, and on the elaboration of contracts for the transfer or acquisition of technologies.
- Support for the certification of products and the maintenance and adaptation of scientific and technological equipment.
- Establishment of partnerships with funding agencies and organizations of employers or entrepreneurs in the region for the implementation of technological projects concerned with the production of goods and services.
- Initiation of a programme of exchanges with expatriates from the diaspora living in the countries of the North, to permit them to place their experience in the service of their countries of origin, by means of sabbaticals, special visits,

Strengthening of institutional capacities would focus on such areas as a high-performance information system, protection and promotion of traditional knowledge, and environmentally friendly technologies.

and interinstitutional, bilateral or multilateral cooperation.

(d) Information exchanges. Scientific and technological information will be exchanged mainly through the information systems of the centres of excellence established in each region and for each priority sector that has been identified (food and agriculture, new and renewable energies, public health, information and communication). The following actions may be undertaken:

- Reciprocal access and interconnectivity of databases or databanks;
- Introduction of a joint bulletin and exchange of publications to link regional centres of excellence working in the same sector of activity.
- Documentation on the successes and failures of partnerships among governments, research centres and production enterprises.

CONCLUSION

In the current context of economic globalization and the imperatives of lasting development, there are many reasons why South-South cooperation in the field of science and technology should be strengthened, given the similarity of economic and environmental conditions in many developing countries. This cooperation could therefore focus on sectors of common interest, such as food and agriculture, new and renewable energies, public health and information and communication.

Specific areas of action to be considered include, in particular, science and technology policies, human resource development, institutional capacity-building (including the establishment of centres of excellence), and the promotion of information exchanges. These regional centres may help to overcome the brain drain.

It is essential, however, for the international community and for the States of the regions concerned to overcome the financial constraints which impede the implementation of the recommendations that have been made. Over and above political will, the mobilization of resources is in fact a prerequisite for ensuring that the countries of the South move beyond pious wishes for greater cooperation in science and technology. ☐

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Knowledge-based Industrial Development and South-South Cooperation

by LYNN K. MYTELKA AND JOHN F.E. OHIORHENUAN*

In the new international competitive environment, business firms in the South need to adopt a much more knowledge-intensive approach to every element of production. The wave of change now even goes beyond the high-tech sectors to a broad spectrum of traditional industries, and places an increasing burden on firms to engage in continuous innovation to survive. How this also opens new avenues for South-South cooperation is discussed by Lynn K. Mytelka, Director, of the UNCTAD Division of Investment Technology and Enterprise Development, and John F. E. Ohiorhenuan, Director of the UNDP Special Unit for TCDC.

INTRODUCTION

Much of the contemporary literature devoted to the emergence of a knowledge society portrays the South as a technology-deficient zone. It points to the rapid pace of technological change and the increasing disparity between North and South in the capacity to produce, use and diffuse new knowledge.

There is much truth to this characterization of a widening technology gap between North and South[1], especially in the area of information and communications technology. But the usual suggested remedies place developing countries in a situation of perpetual *attente* — waiting for transfers of technology from the North, and focusing their attention on the need to attract transnational corporations, widely believed to be the

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*** The views expressed in this article are those of the authors' and not necessarily those of the United Nations.**

principal purveyors of technology and knowledge, to their shores (Dunning: 1992,5; Moran, 1998).

Such an approach seems far too limited. It ignores the extent to which technological capabilities have been built in the South over the past two decades. It fails to recognize that what matters today is not the simple acquisition of technology, but the ability to master it and to innovate. While innovation does depend, in part, upon accumulated stocks of embodied technology and tacit knowledge, the innovation process itself grows out of a multiplicity of interactions between producers and users of knowledge, goods and services and the policies that stimulate and support this process (Lundvall, 1988). In today's digital world, these linkages may be physically proximate or at long distance.

> ***What matters today is not the simple acquisition of technology, but the ability to master it and to innovate.***

These two factors open new opportunities for the accumulation of technological capacities and for learning and innovation through South-South cooperation. What is needed now is the will to move ahead and create the networks and institutions that will make this a reality.

CHANGING COMPETITIVE ENVIRONMENT

The 1970s and 1980s marked the passage away from an era in which technological change was mainly incremental. Time was available to either amortize heavy tangible and intangible investments in new products and processes, or to catch up with a slowly moving technological frontier by mastering processes of production and distribution for what were relatively stable products. Protected national environments were both a blessing and a curse in that earlier period, since they provided time and space for infant industries to emerge, but most often little incentive for them to become competitive whether at home or abroad.

Today, the competitive environment for most firms, irrespective of size, and in most countries, bears little resemblance to that of the pre-1980s period. Over the past two decades production has become increasingly more knowledge-intensive as investments in intangibles such as R&D, software, design, engineering, marketing and management have come to play a greater role in the production of goods and services. Gradually the knowledge intensity of production has extended beyond the high-tech sectors to reshape a broad spectrum of traditional industries, from the shrimp and salmon fisheries in the Philippines, Norway and Chile, the forestry and flower enterprises in Kenya and Colombia, to the furniture, textile and clothing firms of Denmark, Italy, Taiwan and Thailand.

Not only has the nature of production changed, but competition has also become more innovation-based, and it has globalized as markets were liberalized everywhere. This accelerated the pace of technological change and placed an increasing burden on firms to engage in a continuous process of innovation to survive. Many of our assumptions about the catching-up process must now be rethought. In what were once labour-intensive industries, catching up depended mainly upon the static advantage of low labour costs and the ability to learn how to mass produce. Now, catching up and especially keeping up, even in mature industries, requires considerable attention to learning and innovation.

In dealing with this new competitive environment, it is important to move away from the conventional view of innovation as radical change at the frontier of an industry. A broader understanding is that innovation is the process by which firms master and implement the design and production of goods and services that are new to them, whether or not they are new to their competitors — domestic or foreign. Adopting the latter definition extends the concept of innovation to cover continuous improvement in product design and quality, changes in organization and management routines, creativity in marketing, and modifications to production processes that bring costs down, increase efficiency and ensure environmental sustainability. To emphasize innovation in this sense is not to deny the role that research and development (R&D) can play in generating new knowledge. Rather, it serves to underline the importance of innovation in traditional, as well as in high-tech industries.

Innovation of this sort affects the information needs and modus operandi of both firms and states. Firms must learn to manage a portfolio of partnerships and alliances so as to reduce the costs of information and communication, the risks and uncertainties associated with the introduction of new products and processes, and the time needed to move an innovation from the laboratory or design table to market. In a period of dynamic technological change, access to knowledge about changes and organizational arrangements, in market structure and in the strategies of firms, will be critical in catching up and keeping up with a moving technological frontier.

States also must learn new approaches and unlearn policies and the habits and practices that governed policy making in the past. Moving forward will

In the new competitive environment, innovation is not radical change at the frontier of an industry, but firms implementing the design and production of goods and services that are new to them, if not to their competitors.

depend critically on knowledge of the impact of new technologies on society and the environment, and a better understanding of policy dynamics, that is the interaction between policies and the habits and practices of actors whose behavior policy is designed to influence. New channels for dialogue between policymakers, producers and the public-at-large will have to be created, and new forms of networked knowledge-based observatories will have to be put in place to facilitate the task of policymaking and build awareness of new windows of opportunity for development (Perez, 2000). It is particularly in this context that South-South cooperation has a major new role to play.

NEW OPPORTUNITIES FOR SOUTH-SOUTH COOPERATION

Three decades ago there was little real expectation that cooperation in science and technology among countries in the South could become an important complement to North-South linkages for industrial development. Today we know that indigenous people have considerable stores of knowledge, and that this knowledge can strengthen our ability to manage the environment, create alternative forms of productive agriculture, and improve the health and well-being of our populations. Creating the means for these indigenous communities to further develop their knowledge, to adapt it to new conditions and to monitor its impact is a new area for South-south cooperation.

Today we also know that research and development in the sciences and in engineering are alive and well in many developing countries and that they are increasingly contributing to a process of innovation more attuned to the needs of local people and economies. This creative impulse has also been felt in the growing competitiveness of production in traditional industries in many developing countries. Developing countries and high-performance firms within them are playing a greater role in international trade, including intraregional trade, which currently accounts for some 20 per cent of trade by the member countries of the Mercosur and ASEAN (UNCTAD:1995). Intraregional investment among countries in the South is also on the rise (UNCTAD:1998,1999b).

Considerable capabilities in R&D and in production have been built up in high technology sectors. In biotechnology, for example, India, Cuba, Brazil and Singapore have innovative enterprises and research institutions. They have begun to create linkages both with firms and institutes in the North, as well as linkages across the South. More of this might be encouraged and supported, particularly as significant areas of research that are of interest to developing countries in agriculture, the environment and health care are ignored by TNCs from the North. This can be remedied through South-South cooperation.

Significant technological capabilities

have also been developed in the South in information technologies. It is well known, for example, that firms in Korea, Taiwan, Province of China, Malaysia, and Singapore have become major exporters of computers, semiconductors and telecommunications equipment, both as original equipment manufacturers (OEMs) working from the designs of others, and as developers of their own products and brand names. Less well known, perhaps are the intangible exports in software and services from countries such as India (UNCTAD:1998) and Jamaica (UNCTAD:1999a).

In the capital goods sector, the People's Republic of China, Taiwan, Province of China, and Brazil have substantial production capability. In the energy and petrochemical cluster, countries as diverse as Trinidad and Tobago, Mexico, the People's Republic of China, the Republic of Korea, Venezuela and Brazil have developed a range of capabilities.

As a result of these advances, an increasing number of firms from the South are now considered to be viable technology and production partners for firms in the North. These partnerships extend from long-term OEM relationships to two-way collaborative partnerships in research and development. The commonality of problems and complementarities in strengths across innovative firms in high tech and more traditional sectors would make South-South collaboration a useful complement to linkages with firms in the North.

The South has developed significant technological capabilities in information technologies, the capital goods sector, and the energy and petrochemical cluster, and needs to pursue South-South cooperation in environmentally sound technologies, biotechnology, and fuel-cell technology.

The value added of such linkages extends beyond the private interests of the firm to the broader policy interests of government. Building a knowledge base in the South through South-South cooperation, for example, strengthens the capacity of governments to monitor and regulate industries undergoing radical change. This is needed to maximize the benefits from and ensure participation in these industries in the future. The choice of technology available locally needs to be widened by continued local public sector research and development. To be most effective, such research should be leveraged through South-South collaboration. As environmental concerns are increasingly linked to trade, firms in the South are coming under pressure to meet their environmental objectives in a cost-effective way. South-South cooperation can strengthen the ability of developing countries to do so, as we shall see below.

SOUTH-SOUTH COOPERATION FOR KNOWLEDGE-BASED INDUSTRIAL DEVELOPMENT

There are a number of ways that South-South cooperation in knowledge-intensive industries can be enhanced. A few of these are described below.

(a)An effective process of technology transfer is essentially a process of innovation in product, process, and organization or management routines for the firm adopting the new technology. Firms in the European Union (EU) have benefitted from a number of research and technology development programmes, such as the Sprint programme, that transfer technology from company to company and from country to country across the EU. Similar programmes might be replicated across a consortium of like-minded countries or institutions in the South, within regional groupings in Latin America, Africa and Asia, or across them.

(b) There is a strong need to pursue South-South cooperation in the development and diffusion of environmentally sound technologies (ESTs). A recent study on publicly funded R&D on ESTs revealed that a broad range of ESTs is available in developing and developed countries to meet the needs of the developing world. However, only a small proportion of ESTs resulting from publicly funded R&D are commercialized or transferred. The reasons for this include the costly process of obtaining patent rights, lack of knowledge among researchers about the business aspects of technology development, the absence of a policy environment, and an incentive structure conductive to commercialization of research results, and the fact that much of the R&D activity undertaken is still too upstream; consequently, relatively few of the technologies generated in public R&D institutions and laboratories reach the development, commercialization and transfer stages. The mechanisms available to move publicly funded technologies from public institutions to commercialization are limited.

The study also showed that public-sector funding remains a major source of R&D activities, although in recent years its share has declined in most countries. In general, public R&D support has remained higher in developing countries than in the developed world, but it, too, has been declining. Increasingly, the commercialization and transfer of publicly funded technologies has emphasized cost recovery and market-based diffusion of technologies. Publicly funded R&D has thus led to the privatization of new knowledge. This has also limited the diffusion of such technology. Yet there are many points in the generation, development and transfer of ESTs at which public policies provide a critical stimulus.

As the need to develop and implement environmentally sound technologies increases under the pressure of past poor practice and current international rule-making efforts, developing countries will need to work more closely together

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on ESTs. They need to identify and facilitate access to available ESTs, assess their utility in a developing country context, build links to local users through business associations in the South, facilitate transfer and adaptation of these technologies to consortia of local users, and provide follow-up troubleshooting to them. These many steps in the process of moving ESTs in developing countries from laboratory to users require new forms of interstate and interinstitutional cooperation across the South. The Government of the Republic of Korea has already championed this process in the Economic and Social Council of the UN (ECOSOC). It is hoped that other international fora will create additional awareness of the need to build the intra-South institutions and networks that will make the development, adaptation, transfer and utilization of these technologies a reality across the South.

(c) South-South cooperation in biotechnology could significantly speed up development of the South's capacity to choose, create, use and assess biotechnological products and processes for the agriculture sector and the pharmaceutical industry. In May 1999, the UN Commission on Science and Technology for Development (UNCSTD) selected as its substantive theme, "National capacity-building in biotechnology", with particular attention to agriculture and agro-industry, health and the environment. For two years, the Commission will identify ways and means (i) to build an endogenous scientific and technological capacity to develop, adapt and diffuse biotechnology ; (ii) to develop access to the sources of information and strengthen the technical skills to monitor and assess the impact of biotechnology applications and assure their safety; and (iii) to create an endogenous capability to manage and regulate biotechnology. In this context UNCSTD has also decided to be a catalyst in the development of regional centers of excellence in biotechnology in the developing world. Working with other national and international agencies, it will seek to lay the basis for a network of expertise and knowledge to support capacity building in the above areas. These activities will result in high levels of interaction between and across governments in the developing world, as they share experience and expertise in monitoring, assessing and regulating this nascent industry in the interest of public health, environmental sustainability and development. In the development of networked centres of excellence, UNCSTD intends to work closely with existing national and international research institutions and with biotechnology users in health care, agriculture and industry across the South. This will be made possible by the growth of capabilities in research, production and policy analysis that has emerged in a number of countries, such as Brazil, Cuba, India and Singapore, and the strong interest in developing such capabilities expressed by many

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other developing countries.

(d) South-South cooperation in the energy sector is also of growing importance. The development of fuel-cell technology will likely have a powerful impact on the future of this industry. Yet few in the developing world are monitoring the advance of this new technology or assessing the changes it is likely to bring in the complex set of related industries that form the system of production in oil and gas. Changes in the energy sector will also have repercussions for the automobile industry, where competitive conditions are rapidly changing. The solution here is to develop a network of observatories to monitor and assess changes in technology and competitive conditions in these industries.

CONCLUSION

South-South cooperation is by no means a substitute for putting in place in each country an appropriate policy framework that encourages innovation and creativity. Similarly, North-South linkages among enterprises will continue to be extremely important in the industrialization of developing countries. However, over the past three decades the immense additional opportunities inherent in South-South cooperation have become obvious. The advantage of such cooperation lies in the potential of pooling resources to create economies of scale and scope, and to spread the costs and risks of innovation.

The major conclusion is that countries of the South must aggressively establish mechanisms for pooling resources and sharing experiences. One of the most important consequences of the information-communication revolution is that the costs of such cooperation are no longer overwhelming. Creative networking across a wide range of countries, industries and enterprises is now possible via the Internet. But, as a fundamental requirement, developing country governments must be committed to the task of minimizing the transaction costs of innovation.

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NOTE

[1] In 1996, OECD member countries had on average well over 500 main telephone lines and more than 200 personal computers per 1,000 people. In contrast, only 14 developing countries, most of which are Caribbean Islands and Gulf States, have more than 200 main telephone lines per 1,000 population, and the vast bulk of the developing world has less than 100. Sub-Saharan Africa, excluding South Africa, has only 5 main lines per 1000 people. The gap is even wider in personal computers. Only 1 developing country comes close to the OECD level, and no other even approaches 40 percent of the OECD penetration rate. The high level of telephone and computer penetration is paralleled by the North's ability to influence culture, which dominance of the Internet permits. Thus OECD member countries in 1998 averaged 34 internet hosts per 1,000 people each, while most developing countries have less than 1 per 1,000. (UNDP:1999, A1.3),

Cooperation in Science and Technology:

DEFINITIONS, QUESTIONS & VISIONS

by JOSEPH O. OKPAKU Sr.

A thoughtful approach to science and technology considers the social dimensions and intellectual process, not only the techno-economic aspects of research aimed at designing the future. What future? Defined how? Based on what vision? With what long-term search on the frontiers of knowledge, balanced how with targeted problem-solving? Joseph Okpaku Sr., President and CEO of the Telecom Africa Corporation, offers some broad philosophy.

SCIENCE AND TECHNOLOGY is about designing the future in an attempt to minimize the destabilizing prospects of coping with the unknown. Whether it is the soothsayer of a long time ago, the voodoo priest, or the research scientist of today, the inspiration is the same: how do we anticipate tomorrow and put in place, today, the mechanism for not being taken by surprise when tomorrow comes. This starts with a very tangible task — to devise a framework for defining the challenges before us, highlighting the opportunities they present, and designing the strategies for our response and practical programmes for building the capacities for effecting the changes we seek.

The primary preoccupation of science and technology, even in the realms of social science and the humanities, is about designing the future. The notion of designing the future might appear to be an oxymoron. But contemplating the alternative, in light of the dizzying rapid pace of changes in our everyday life, is to risk sleepwalking through time with the nightmare possibility of being swept ashore on the beaches of tomorrow, marooned in time and space.

THE CHALLENGES

We cannot design the future without first deciding where we want to go, and indeed, defining where we are. Otherwise, it would be like going to the airport and asking for the next flight to anywhere. What do we really want to do with the enhanced capacities of science and technology? What kind of society do we want to build with science and technology? What kind of life are we seeking to craft using science and technology? What impact do we seek to bring about? At what cost? In other words, what price are we willing to pay for taking advantage of the products of science and technology?

These questions need answers, not necessarily today, but before we proceed to generate the resources and galvanize the energies and synergies necessary for accomplishing the significant cooperation in science and technology we seek among ourselves, the people of the South.

> ***If there is one capacity we must seek to strengthen in South-South cooperation, it must be the dual ability to dream to reach for the sky without hanging our heads in the clouds.***

This touches on critical issues of culture, society, quality of life and life style, and science and technology. For science, and the technology it gives birth to, should be a tool, just a tool, to shape and advance culture and civilization. But the reality is that science has developed its own culture, a culture sometimes so powerful that it has threatened to undermine human culture in societies which have achieved the greatest advancement in science and technology. The price innovators pay for change can be high. The advantage of being a latecomer is that by good judgement we can avoid making the same mistakes.

DEFINITIONS – WHAT SOUTH?

The next question is one of definition. Who really is the South? At a recent international conference on TCDC, the notion of the "First South" and the "Second South" was broached, perhaps dangerously, perhaps inadvertently, by one participant. That idea drew such forthright reactions that it was shot down and withdrawn. But it was significant. Like all knowledge, once conceptualized and voiced, it comes into existence and cannot be said not to have been. The tacit assumptions are that, first, some developing countries occupy the top of the highway of human development, and others hang out in much less elevated positions; and second, that the struggle of policy makers and the scientists and other experts they lead to rush the process of joining the top of the class involves a journey which is perpetually northbound.

For those of us from economies presently (and only presently) too far back to be seen as approaching the gate of the OECD, we would be disingenuous if we did not admit the anxieties the dynamics of economic progress give us. The question can be posed gently, as what happens to South-South cooperation in science and technology when part of the South moves north, especially if we anchor our strategies and pin our hopes too strongly on the northernmost or most northward-bound of our Southern fraternity?

This is a difficult and perhaps uncomfortable question. But we are scientists and engineers, strategic planners and leaders, and we are trained to address complex and challenging questions, often with little data to go by. If there is one capacity we must seek to strengthen in the South-South cooperation we seek to create, it must be the dual ability to dream to reach for the sky without hanging our heads in the clouds. The challenge is not just for our Korean friends and Indian friends and Brazilian friends, but for us Nigerians, us Peruvians, us Sri Lankans. The better we understand and master this illusive question, the better we are equipped to design the right foundation for our cooperation, minimizing its uncontrollable vulnerability to constant change.

TOWARDS A NEW VISION OF DEVELOPMENT OBJECTIVES

At the bottom of this challenge must be the realisation that the psychology of the rich and the poor, and the inevitability of certain dynamics to sustain wealth, must be reexamined to fit the future society we wish to build with science and technology. Can we develop, through South-South cooperation in science and technology — which really means cooperation in economic and social development, using the cutting-edge tools of science and technology — a new society in which the order of the day is quality of life, not the differential advantage of wealth defined only by the relative impoverishment of others?

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What kind of science and technological capacity we seek to build, and how we seek to deploy it, will be determined by the answers to these delicate questions. All these are issues of vision-our vision for a better tomorrow, and how we can use our specialty of science and technology to bring it about.

RESOURCES AND PARTNERSHIPS

Science and technology is essentially a process of problem-solving. One of the debilitating weaknesses in problem-solving is not defining the problem accurately. If you define your problem wrongly, chances are your solutions will be flawed, creating new problems in the dynamics of change, which preclude prospects for an efficacious solution. What really are the composite resources we have and need in the deployment of science and technology for development? A vision, a demand, human and material resource, opportunity, social and political will, and the psychology of empowerment, especially self-empowerment, with the belief that the sky is the limit and that nothing is impossible given the capacity of human genius.

But how do we know what we need and seek to increase it if we do not know what we have? We in the South, given our little access to the management of information and the promotion of public enlightenment, do not have a fair knowledge of our existing capacity. What expertise in science and technology do we already have? What do our boys and girls know? What can they do? In this regard, our existing expert capacity in science and technology is so underestimated that we suffer an unnecessary psychological self-handicapping from thinking that we know much less than we really do.

Therefore, a major priority in constructing the mechanism for the South-South cooperation we seek must be a programme to identify, qualify and quantify existing scientific expertise in the South. At Telecom Africa Corporation, we are building the capacity to do this in various fields. For example, we are working with the ITU to undertake a global human resource survey of African male and female expertise in the field of information and communications technology as a strategic tool for planning, employment, and nation-building.

Another challenge is the mutuality of exchange inherent in the notion of cooperation. An environment or arrangement in which one party is seen as having all to give, and the other as needing all, is not cooperation but slavery and dependence in whatever linguistic configuration may be acceptable to the order of the day. So we must face the question: What does each of us bring to the table? What can we gain from the alliance? What are the mutual benefits of the liaison we seek? If we face this challenge properly, we will come up with surprises. Because not only does each of us have so much to offer the other, no matter how advanced or successful,

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seemingly poor or underdeveloped, there is much we have already offered.

At the Seoul International Airport recently, I witnessed a professor arriving and being met by his former student, now a professor and an expert in electrical engineering. The arriving professor was an African, the former student, Korean.. African professors of science and engineering have been teaching and training Koreans, Indians, Brazilians, indeed Americans and Europeans for years, and many of those graduates are now the experts who form the driving force behind the phenomenal developments in these countries. So, we do need to know what we have, and use it as the foundation for our own development and as what we bring to the table in this cooperation.

DIFFERENT TYPES OF RESEARCH

Research is the foundation of science and technology. While the specific focus may differ and should be selected with specific priorities in mind, we must be careful not to undermine the very nature of research as the exercise of the inquiring mind into subjects which often are purely related to the private interests of the scientist. We must be careful, therefore, not to circumscribe the freedom of intellectual pursuit with a systemic or systematic constraint based on shortsightedness about our short-term needs. The two strands of interest, research to find practical solutions to pressing current needs and research as the attempt to access the frontiers of knowledge, are not incompatible. We must marry both types of research, because ultimately it is the knowledge which pure research creates which provides the intellectual material for formulating the applications which we deploy as technology.

Like all searches in the twilight between the dawn of the known and the dusk of the unknown, pure research, for lack of a better terminology, tends to be cost- and time-intensive, often taking years to yield concrete results. This has led to the belief that the so-called high-tech research by financially strapped countries is an act of grand delusion. But sometimes big problems compel big solutions, and some of the challenges of development cannot be called small.

And yet the paucity of financial resources is a harsh reality. We must find the means and strategies for marrying both needs if only because the very economic transformation of a given society may lie in the inventions and innovations of a single scientist or small group of scientists. That possibility, like all pursuits of self-actualization, must be kept alive. There are many examples in history. The challenge is for our financial and strategic planners to exercise their genius in the selective allocation of scarce resources.

FINANCING, RISKS AND ACCESS

One recognizes the constraints of scarce resources available to countries of the South, especially in the face of life and death priorities. But the pursuit of capacity in science and technology could also be a matter of life and death, and finding the solutions to the threat of death and disease is critical in order to sustain and enhance the quality of life. The question of how to find money for science and technology, especially for research, is a perennial one. The cries continue to go out for assistance from external sources. The response will continue to be uneven and uncertain—in fact, it is dwindling.

The challenge to countries of the South, while seeking the generosity of the North, is to devise new strategies for obtaining funds internally and on a South-South basis for jump-starting their own scientific development. There comes a time in the life of a people when, no matter how embattled, they must take their destiny in their own hands; and armed with their own limited resources (strategic, material, human, spiritual and otherwise), strike out to build their own future, with the help of friends, if possible, alone, if inevitable.

The two strands of interest — research to find practical solutions to pressing current needs and research as the attempt to access the frontiers of knowledge — are not incompatible.

Our analysis would be incomplete if we do not admit that there is inherent risk in long-term research investment. It can all be futile, or, more often, be inconclusive, while resources run dry. One of our challenges is to build the kind of coalition of public, private and third-party funding with potential benefits to all players.

There is also the challenge that, after all is said and done and collaboration in science and technology yields capacities and products, what do we do with the products? How do we ensure the market access of these products? What rules will govern the exploitation of the fruits of our joint efforts? Basically, there must be equity, mutual access to each other's markets, and a comparative, competitive capacity, or in the absence of that, there must be affirmative action programmes to create this competitive capacity.

AN OPPORTUNITY FOR INNOVATION AND INVENTION: HIV/AIDS

The greatest science and technology challenge of our times is the need for a vaccine for HIV and a cure for AIDS. In the dichotomy between "realistic" research and "esoteric" research, the former being the presumed realm for the South, and the latter the preserve of the North, where would we place AIDS research? If the *raison d'être* of research, science and technology is to solve critical challenges to the quality of our lives, what could be more immediate to us than finding the cure for a condition which threatens our very existence?

To further complicate the situation, should the South fail to invest in finding an HIV vaccine, and the North does, and given the anticipated cost of access to such medications, will the South then be able to afford it? Would we not be caught in the throws of a Catch 22 situation in which we play only a losing card?

Even more, given the fundamental irrevocable nature of human commitment to sexuality (whether for procreation or pleasure, or for power and control), what would be the estimated return on investment for a successful discovery of an AIDS vaccine and a cure? Could such revenue not totally transform the economic condition of the countries of the South which join a coalition to produce such a vaccine and cure? Would this not be a sound investment of human, intellectual, material and financial resources? Would that not be a legendary achievement of South-South cooperation in science and technology?

And why not? What would it take? We have the expert microbiologists, biochemists, geneticists, medical researchers and others we would need. We even have the most important resources needed, the AIDS-infected patients and their genetic samples. We have even been told that we have people in Nairobi who appear to have HIV antibodies, providing the nearest promise of a successful engineering of a vaccine. But, alas, they are being flown out of the South, and already being claimed as the property of Canadian and European researchers. Whose problem? Whose solution? Who profits? Who pays?

If one had only one wish, I would like to recommend as a major concrete initiative the formation of a South-South medical research effort to find a vaccine and cure for AIDS as a priority of the South.

CONCLUSION

There are numerous other areas of critical need where we believe specific collaboration holds much promise. There are lots of other issues to explore. At the end of the day as scientists and technologists, strategic planners and officials, our ultimate human effort is to make life a little better for more people, and to continuously extend the boundaries of knowledge and capacity in the search for human freedom and creativity in whatever formulation we and our environment and culture define it. ☐

FROM IMITATION TO INNOVATION:

Technology Transfer and Adaptation North-South & South-South

by HOKOON PARK

Developing countries need to find "a new growth engine based on technological innovation." To this end, what does experience say about the best approaches to acquiring, adapting and managing appropriate technologies? One essential method is cooperation among developing countries with similar levels of development, says Hokoon Park, President of the Korea Institute of Science and Technology (KIST).

INTRODUCTION

The importance of technological innovation for sustainable development was clearly shown in east Asia's recent economic crisis. The remarkable economic growth in the region, including South Korea, received worldwide attention over the last 30 years. In 1997, economic crisis struck, leading to serious economic stagnation and high unemployment, while collapsing the myth of the East Asian "miracle." Lately, economic recovery has been significant, but the sustainability of economic growth in east Asia is still uncertain.

It is widely debated whether the economic crisis of east Asia was mainly due to the vulnerable financial system and reckless overinvestment by industries. Because of inefficient capital use and excessive production capacities in many industries, recent economic reform in east Asian nations has focused on financial and corporate restructuring. However, it is still uncertain whether the restructuring is sufficient to ensure sustainable economic growth.

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Some experts believe there are other, more fundamental obstacles to this goal in east Asia. For example, Paul Krugman of Massachusetts Institute of Technology and author of "The Myth of Asia's Miracle" in 1994, held that rapid economic growth in east Asia would reach a limit because it was mainly achieved through rapid increases in capital and labor input, rather than by technological progress. Another example, concerning the Republic of Korea, is the view that its economy is hindered by a knowledge gap with developed countries, according to Booz-Allen & Hamilton, a well-known international consulting firm. These arguments clearly show the reality which east Asian economies now face: a key to their recovery is to strengthen technological capabilities and find a new growth engine based on technological innovation.

In the east Asia region and other developing nations, knowledge based on science and technology is critically important for sustaining economic growth in the next century. However, it is an extremely difficult task for developing nations to narrow the technological gap with developed nations because they have weak technological bases and lack resources for research and development (R&D). Enhanced cooperation in science and technology (S&T) can be a beginning step to overcome this difficulty. The Republic of Korea, for example, has 30 years' experience in science and technology development which can help other developing countries. As discussed below, one valuable lesson of experience concerns the roles and partnership relationships of the main national cooperating bodies — the government, R&D institutions, and the private sector.

THE CHANGED ENVIRONMENT FOR SCIENCE AND TECHNOLOGY

Science and technology is undoubtedly a key determinant for ensuring the long-term economic growth and the future prosperity in today's industrialized world. Consequently, the building of a strong capacity for technological innovation should be placed at the top of the agenda in developing countries. In today's world, competition and cooperation are parallel routes for the development of that capacity and the acquisition of technological advantages.

S&T cooperation has so far mainly taken place among developed countries, which can achieve useful trade-offs under the principle of mutual benefits. However, cooperation between developed and developing countries has been limited because the latter have little or no complementary assets to attract partners from developed countries. According to OECD, 96 per cent of 1,250 technological alliances made during 1980-1989 were among developed countries, primarily in high technology areas. Only 4 per cent were between developing and developed nations. In addition, international collaborative programs of R&D have been undertaken mainly among developed nations.

Clearly, developing countries need to find a new growth engine through technological innovation. But they face a severe challenge from the changed international environment for science and technology. Developed nations have been strengthening technological protectionism and intellectual property rights, making it more difficult for developing nations to acquire advanced technologies. In addition, there is a movement to make new international "rules of the game" that would restrict government support for the development of industrial technology. If developing countries are to sustain their economic and industrial growth in this new environment, an essential alternative is that they step up S&T cooperation among themselves.

For the Republic of Korea, such cooperation is very important as it prepares to make the transition from technological imitator to innovator. It has made remarkable achievements in accumulating technological capabilities over the last three decades. Today, it has cutting-edge capabilities to produce and export competitive products in several technology-intensive industries such as semiconductors, information and communications equipment, steel, and automobiles.

Korea's success in science and technology development over the last 30 years has been largely due to the government-led system and the creative adaptation of transferred technologies from developed nations. The Government played an important role in establishing R&D bodies such as GRIs (government-funded research institutes) and in adopting policy measures that promote R&D activities. GRIs such as the Korea Institute of Science and Technology (KIST) contributed to establishing a technological base by introducing the modern R&D management system and cultivating experienced R&D human resources. GRIs have led Korea's technological progress by building in-depth capabilities for industrial development.

Korea accumulated cutting-edge technological capabilities also through efforts by the private sector. It creatively adapted foreign technologies and, in particular, refined standardized mass production technologies. This success would not have been possible without big challenges, high risk-taking, ambitious goals, and long-term commitments by individual companies. It also took top management leadership in mobilizing R&D resources and establishing an advanced techno-management system.

However, Korea finds itself today in a very different situation. The government-led system is now considered less efficient due to the greater sophistication of the industrial structure and the rapid growth of R&D capabilities in the private sector and academia. Also, technology transfer from developed nations is getting difficult, and imitation-based approaches are no longer available in the new environment. In addition, Korea has reached a point where technological advancement is no longer achievable without developing its own core technologies.

This changed environment requires a new paradigm for science and technology development in Korea. The core of the new paradigm is to make the transition from imitator to innovator. To accomplish this, S&T cooperation with developed nations is very important. At the same time, S&T cooperation with developing nations can have great potential, because it can create valuable opportunities which are not available from cooperation with developed nations. For example, countries such as Russia, China, and India are strong in basic science, and this is an important complement for Korea's effort to develop core competencies in emerging technologies. Also, transferring Korea's standardized production technology to developing nations will provide them with opportunities to import technology from new sources and also provide opportunities for Korea to expand future economic cooperation.

> ***Companies need to take high risks and make long-term commitments to adapt foreign technologies and create cutting-edge production and export capabilities.***

CURRENT ISSUES IN SOUTH-SOUTH COOPERATION

South-South cooperation in science and technology should be viewed not as a substitute for, but a complement to, North-South cooperation. As we can see in Korea, it is very important for developing nations to expand cooperation with developed nations in areas of emerging technologies. It is also important for developing countries to share complementary assets among themselves. In this perspective, Asia Pacific Economic Cooperation (APEC) is a case in point regarding South-South cooperation in science and technology.

APEC was established in 1989 to facilitate trade and economic cooperation among member countries. Its 21 participants include the United States, Japan, Korea, Taiwan, Province of China, Vietnam, and the Philippines, covering a wide spectrum of developed and developing countries. APEC is currently expanding its areas of activity from trade and investment liberalization to S&T cooperation.

Among APEC S&T cooperation activities, human resources and technology information exchange is the most active field. An example is the APEC Science and Technology Network (ASTN), whose main activities are exchanging researchers, training R&D managers and establishing information networks. The training programs share experience in science and technology development and seek to narrow the technological gap among member countries.

However, S&T cooperation in APEC is still very limited compared to its potential, and has lower priority than trade and investment liberalization. It is too soon to expect tangible outcomes in only three to four years of S&T cooperation.

To facilitate S&T cooperation in APEC, we have several obstacles to overcome. From these obstacles, we can learn valuable lessons to strengthen South-South cooperation in science and technology. First, adjusting conflicting interests among member nations is very important for closer S&T cooperation. In APEC, it is not easy to find shared objectives for S&T cooperation because member nations have different levels of economic and industrial development. Developed nations share more interests in S&T cooperation — for example, in global environmental preservation — while developing countries are more interested in technology transfer from developed nations. These kinds of conflicting interests will come out in South-South cooperation as well as in North-South cooperation. Seeking opportunities for mutual benefits is an important factor for strengthening the S&T cooperation among developing nations.

Second, differing legal and administrative frameworks at national levels hinder effective cooperation among member countries. The absence of intellectual property laws is a major impediment to technology transfer, not only from developed countries, but also among developing countries. Improved laws governing patents and trademarks would facilitate S&T cooperation.

Third, the huge technological gap between countries has an adverse effect on S&T cooperation. Because of the gap, technology transfer from developed nations is not always appropriate for industrial development. This leads to increased scope for S&T cooperation among developing nations which have similar levels of industrial and economic development. To overcome this problem, it is vital for developing nations to increase capabilities of technology absorption and application, granting that developed nations are willing to transfer their technologies. However, leading developing nations such as Korea can play an intermediary role in narrowing the North-South technological gap. Furthermore, Korea will be able to promote science and technology exchange by adjusting conflicting interests between developed and developing nations.

Technology transfer from developed nations is not always appropriate because of the huge technological gap, but there is wide scope for science-technology cooperation among developing nations with similar levels of development.

ROLES OF GOVERNMENT, R&D INSTITUTIONS, AND PRIVATE SECTOR

Successful S&T cooperation among developing countries requires not only improved coordination by governments, but also better communications and interactions among R&D institutions and the private sector. However, cooperation efforts have primarily centered on governments and on creating collaborative treaties and agreements — a "top-down approach", which is not sufficient for the promotion of S&T cooperation among developing countries.

For effective technology cooperation, all governments, R&D institutions and private sectors need to take collective action to implement cooperative programs based on mutual benefits with common objectives. This "bottom-up approach" entails building diverse channels and promoting wider and in-depth cooperation among developing nations. While government, R&D institutions and the private sector play distinctive roles in S&T cooperation, their roles should also be integrated in order to obtain maximum efficiency in technology cooperation. In this perspective, we would like to suggest some basic principles of each cooperating body by providing Korea's cases and examples.

A "top-down" government-directed approach is not sufficient for promoting S&T cooperation among developing countries; R&D institutions and the private sector also have important roles.

Government

Governments should work closely together through high-level meetings of policy makers and administrators so that past successful experiences in the formulation of S&T policies can be shared. In particular, it is very useful to learn about the policy and administrative experience of countries which have achieved rapid industrial development through efficient utilization of imported technology.

A great number of technology transfer and exchange programs have been implemented, mainly through government agencies. However, little technology can be transferred successfully from one culture to another if the software of a technology is not regarded as important as the hardware. Software in this context refers not only to the know-how, operating experiences, and maintenance skills associated with the technology, but also to adaptation to the cultural context and previous experiences of the receiving organization and society which are going to use it. The software must match their education and skill levels and enable users to operate the technology efficiently. This aspect should also be covered in high-level meetings of government policy makers and administrators, especially as regards ways of monitoring the transfer and sharing of S&T policy experiences to ensure proper adaptation.

> ***Little technology can be transferred successfully from one culture to another if the software of a technology is not regarded as important as the hardware, including its cultural adaptation.***

Also, governments of developing nations should further intensify their cooperation by establishing an appropriate infrastructure, such as information networks. This is crucial for the exchange of experiences in technology development and for cooperation among R&D bodies, especially for manufacturing industries. Private sector businesses always need information sources to find opportunities that can generate commercial benefits from outside. In Korea, establishing the information network is an exclusive role of the Government, which will continue its efforts in order to bring tangible results.

R&D institutions

R&D institutions of developing nations should increase their interactions, strengthen their relationships and encourage collaborative activities. Their cooperation can be very effective because they have practical experience in technology development, which provides a sound basis for sharing know-how with other developing countries.

The Korean Institute of Science and Technology (KIST) is currently helping Vietnam create a public research institute modeled on KIST. Such R&D institutions can build national technological capabilities for industrial development. The assistance includes training of researchers, providing expert services, and granting research facilities. This collaboration has great potential for expanding cooperation between public bodies as well as between private sectors. We can see it clearly from the case of KIST, which was founded with initial help by the Battelle Memorial Institute (BMI) in the United States. BMI consultants helped design research and management systems, contributing not only to successful functioning of KIST, but also to efficient technology inflow from the United States. Assistance from KIST to Vietnam is expected to produce similar effects and typify the bridging role which Korea can play in S&T cooperation with developing countries.

R&D institutions in developing nations should make active efforts to enhance their scientific and technological capabilities by exchanging their R&D resources. Collaborative research projects are commonly undertaken with developed countries, but opportunities are also available with developing countries, and KIST is an example of both. The Korea-Russia scientific and technological cooperation center in KIST combines Russian capabilities in basic technologies and Korean capabilities with applied technologies for actual products, and has achieved several significant research outcomes, including laser-mirror technologies. Also, about 100 visiting researchers from developing nations each year conduct research projects at KIST in areas such as new materials, information technology and environmental science.

The private sector

Technology cooperation is likely to be most successful in a commercial setting involving mutual benefits by two business entities pursuing their commercial interests. However, more private sector businesses need to recognize the benefits of South-South cooperation in science and technology as an important complement to traditional North-South cooperation. Finding the available resources and opportunities for this is still difficult, but there are several examples available from Korea.

Korean software businesses are rushing to establish research laboratories in India, which has outstanding software engineers and a huge potential software market. Sharing their technical expertise and trained human resources is a typical win-win situation for both countries.

Another example is the transfer to developing countries of Korea's standardized production technologies in such industries as home appliances and automobile assembly. Some major Korean companies have already made considerable investment in developing countries, especially in southeast Asia. They are enjoying considerable success in sharing price competitiveness and building future potential markets.

Private sector cooperation among developing countries can help local industrial firms initiate science and technology development, acquire modern management techniques, production technology and know-how, and narrow the huge technological gap with developed countries. As shown in our Korean experience, it can save time and effort to share technologies which have already been adapted to local cultural conditions in a developing country.

As mentioned, government-centered cooperation and a "top-down approach" are not sufficient to widen and intensify S&T cooperation among developing nations. A "bottom-up approach" is needed to facilitate cooperation, especially in the new science and technology environment. Also, each cooperating body should find its role in the bottom-up approach. Important as the role of the government is in providing a favorable environment, mechanism and infrastructure, successful cooperation among developing nations also calls for voluntary cooperation by R&D institutions and the private sector.

CONCLUSION

In the new science and technology environment, S&T cooperation among developing nations is becoming critically important for achieving social and economic development. Developing nations must continue to shape a long-term, integrated strategy for pursuing S&T cooperation among themselves. To this end, some basic principles for facilitating S&T cooperation among developing nations need to be reemphasized.

First, successful cooperation requires a common ground which facilitates the sharing of objectives, goals and benefits. While developing countries often express the wish to increase S&T cooperation among themselves, real results fall short because their interests do not coincide as easily as their wishes, and because it is difficult to establish a common ground and mutual benefits. There is good potential for mutual benefits from partnerships in the utilization of complementary assets, joint development of natural resources and energy, and shared efforts to resolve environmental problems.

Second, governments, R&D institutions, and the private sector have different and distinctive roles in S&T cooperation. Governments' important role is to initiate and facilitate cooperation by creating a favorable environment and institutional framework. R&D institutions and the private sector have a leading role in making cooperation effective and successful. To this end, they should increase interactions among themselves, exchange personnel and information, and forge closer continuing linkages.

Finally, there is no single approach to effective and successful S&T cooperation among developing countries, especially South-South technology transfer. Prerequisites include shared objectives, mutual benefits and active participation by all R&D bodies — and clear understanding of these conditions. S&T cooperation among developing countries is no longer optional, but mandatory if they are to achieve sustainable economic development in a new science and technology environment. ☐

There is good potential for mutual benefit from developing country partnerships in the utilization of complementary assets, joint development of natural resources and energy, and shared efforts to resolve environmental problems.

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S&T Innovation and Cooperation

IN LATIN AMERICA

by GUILHERME ARY PLONSKI

Nationally, Latin American countries are struggling to get the many actors involved in S&T and development to work together. Internationally, a main format is South-North-South cooperation. Now the challenge is to reshape the agenda for both national and international cooperation so as to tackle the problems of employment, poverty and productivity in the region. Ways of doing this while keeping to rigorous methods and social relevance are discussed by Guilherme Ary Plonski, who is Executive Coordinator for University Cooperation and Member of the Board of Directors, Center for Technology Policy and Management, University of Sao Paulo, Brazil.

THE INNOVATION TRIANGLE

Latin American political thought has long grasped that science and technology must be embedded in the very process of development. That integration was seen as essential in order to overcome what used to be called underdevelopment. In the 1960s, there was talk of attaining this goal by the then distant year 2000. A key aim was to strengthen relationships between three main actors: S&T infrastructure, the production structure, and government policies. Working on this task, presented by Jorge Sabato and Natalio Botana, in what became known as "Sabato's Triangle," would not be easy in the Latin American region. It called for these actors to change their habits significantly. They were accustomed to promoting relationships with institutions of the same kind clustered within each vertex of the triangle, and with such triangles in other countries, mostly in the North.

As the year 2000 finally arrived, it should be pointed out that the two

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thinkers were right. Some progress towards articulation among these three major actors in Latin American societies occurred, mainly in the 1990s, and several cases of good practices should be recognized. However, most countries are still struggling to reinforce the base of the triangle by mainstreaming cooperation between the academic world (universities, public and private research institutes, R&D centers) and the production system (both large and small companies, and also the informal sector, which is very strong in the region).

Advances in this direction were accelerated during the last decade under the influence of new international economic competition, the emergence of new technologies, mainly in information and communications, and the changing role of the State. New institutional settings for S&T appeared in many countries in Latin America, seeking to enhance its role in providing some of the knowledge needed by a mostly fragile production system.

While still useful, the triangular national model has evolved in many ways, and its geometry became more complex. Actual innovation systems showed that, besides the three originally perceived actors, at least seven other types of actors are involved — the financial system, technology brokers, industry and professional associations, the legal base (especially IPR issues), NGOs, press/public opinion, and international cooperation structures.

THE COOPERATION TRIANGLE

Multilateral cooperation in the area of S&T is widespread in Latin America. Some of it is purely intraregional, and most of that is subregional. In many cases, however, the institutional arrangements constitute another kind of triangle — South-North-South.

The most impressive triangular case is the Ibero-American Program of S&T for Development, known by its Spanish acronym CYTED. It was created in 1984 by means of a frame agreement among the 21 Spanish and Portuguese-speaking countries of both sides of the Atlantic Ocean. CYTED facilitates technological development and innovation by coordinating existing resources and promoting cooperation among universities, R&D centers, and innovative companies in the region. Its goals are to stimulate cooperation in applied research and technological development whose results can be transferred to productive systems and social policies in member countries.

The Program is organized around 16 subprograms. Two subprograms are horizontal — methodology, with a focus on S&T indicators; and management of technological R&D, with a focus on industry-university cooperation. Fourteen subprograms are thematic, covering aquaculture, biomass as a source for chemicals and energy, new sources and energy conservation, materials technology, pharmaceutical fine chemistry, biological diversity, mineral technology, corrosion/environmental impact of materials, biotechnology, catalysis and adsorbents, applied electronic and informatics, microelectronics, food treatment and conservation, and social housing technology. Around 10,000 S&T professionals have been involved.

There are three main modes of operation in CYTED: (i) Thematic Networks, which facilitate the interaction, cooperation and transfer of knowledge and technologies among groups with similar interests; (ii) Precompetitive Research Projects, performed by an international team with peole from universities, research institutes and companies; and (iii) Iberoeka Innovation Projects, which promote applied research between companies of two or more member countries. In 1999, there were 47 networks, 52 precompetitive projects, and 124 Iberoeka certified projects in operation.

The Program has a reasonably decentralized and flexible management. The Spanish Government pledges to cover at least 50 per cent of the costs; in fact, it currently provides two-thirds of the yearly budget of US$ 6 million. Many networks and projects are able to leverage funds received from CYTED by applying to national and international sources. The Program was externally evaluated in 1992, having been considered one of the most effective international cooperation programs in terms of cost/benefit.

Several other initiatives for S&T cooperation for development and for higher education which operate in Latin America also follow the pattern of the South-North-South cooperation triangle. Some of them will be briefly mentioned.

- The Columbus Program, an initiative of the European Council of Rectors of Universities, encourages collaboration among Latin American universities which help create and manage technological incubators and promote university cooperation with small companies. One spin-off is the Latin American and Caribbean University Network for Continuing Education (RECLA is the Spanish/Portuguese acronym), which gives high priority to distance education.
- The Latin American Association of Technology Management (ALTEC), established some 15 years ago, shares experience across the region in S&T policy and management for development. At its biennial seminar in 1997 in Havana, it was decided to expand the Association by including Portuguese and Spanish technology managers.
- The Council of Industrial Research Associations of the Americas (CIRAA) is a recent initiative to promote technology-based innovation in Latin American industries. It groups the national company R&D associations which operate in Latin America, USA and Canada.
- Secretaria del Convenio Andres Bello (SECAB) is an agreement

among the countries of the Andean zone, Panama and Spain, which promotes cooperation related to culture, education and S&T.

- The Organization of Ibero-American States (OEI), which is 50 years old, recently started promoting cooperation in S&T, stressing the issues of society and innovation.

THE CASE OF THE SOUTH COMMON MARKET

The South Common Market, which has the acronyms MERCOSUR and MERCOSUL in Spanish and Portuguese, respectively, was created by Argentina, Brazil, Paraguay and Uruguay in March 1991 through the Asunción Treaty. After a three-year transitional period, an institutional structure was established in December 1994 through the Ouro Preto Protocol. The Specialized Meeting for S&T, known by its Spanish acronym RECyT, became the specific forum for S&T issues. Since 1996, Bolivia and Chile have been included as associate members, creating a kind of Free Commerce Zone.

S&T cooperation among the constituting countries preceded MERCOSUL. The most notable cases were in biotechnology, through a binational center (known by the acronym CABBIO), and informatics, through a binational high-level school (known by the acronym EBAI). There is also a tradition of grants for a significant number for undergraduate and graduate study programs, mainly offered by Brazilian universities (with a considerable presence of African students, mainly, but not only, from Portuguese-speaking countries).

A thorough study on the role, patterns, and tendencies of S&T cooperation in MERCOSUL was recently completed. It was done by Léa Velho and a multinational academic team, sponsored by the Brazilian Ministry of S&T under the auspices of the Organization of American States (OAS). The main conclusion is that Mercosul countries are still low in the international cooperation agenda of all kinds of institutions contacted — governmental bodies, universities, research institutes and companies — state-owned or private.

Notable examples of institutional cooperation programs include one in the field of agriculture involving bromatological and phytosanitary issues (known by the acronyms PROCISUR or PROCISUL). This is consistent with the emphasis on life sciences in the spectrum of Latin American research. Other areas of relevant cooperation focused on the harmonization of industrial norms and standards. In the academic sphere, the Montevideo Group of universities is an example of lasting intraregional cooperation in many fields.

The major channels of international cooperation in S&T continue to extend from each MERCOSUL country to North America and Europe, the same as with most Latin American countries. Indeed, the bibliometric part of Velho's study found that Mercosul had not yet caused noticeable changes in this traditional pattern. The main reasons are that Latin American countries are attracted by the high level of the scientific base and available funds in Northern countries, that graduate students from the South develop attachments to their Northern advisors, and that Mercosul countries are characterized by intraregional asymmetry.

Velho's study illustrates the importance of triangular relationships by analyzing publications. It found that, in 1980-1995, 30 per cent of the papers published by researchers from two or more MERCOSUL countries also had a coauthor from the USA or Europe, as shown in the Science Citations Index (SCI). This is consistent with the increase in cooperation between MERCOSUL researchers that has been indirectly due to interregional cooperation programs, mainly some of the ones mentioned above.

There are no precise estimates of the extent of international collaboration by companies in MERCOSUL countries, but there are figures for Latin America as a whole in a study done for the United Nations University (Alcorta, 1998). Similarly, the study shows that Latin American firms accounted for only 4.3 per cent of the approximately 6,700 international technological agreements entered between 1980 and 1994. The study also analyzed data on 23,802 collaborations in information technology between 1984 and 1994. It showed that Latin American firms accounted for 15.5 per cent of the total, behind Asian firms, with 61.6 per cent, and firms from Eastern European and the former USSR with 21.2 per cent. Within Latin America, Brazil accounted for 3.4 per cent, and Argentina for 1.8 per cent of the agreements. In 11 case studies, the authors also note that "unlike most of the experiences recorded in the literature" the technological collaborations by MERCOSUL companies were "concentrated in medium to low-technology sectors, or in relatively less advanced technologies, such as garments, mechanical engineering, or at the lower end of pharmaceuticals and biotechnology."

A first set of policy recommendations from the study focused on four needs: increase the efficiency of existing government programs aimed at innovation; make information on the potential of technological collaboration and on possible specific cooperations more widely available; allocate specific funds or loans for technological partnering; and support strictly technical collaboration agreements with firms that have no presence in MERCOSUL.

Another area for public policy is complementing supply with demand-oriented incentives, such as government procurement policies (as has been done in Korea and Taiwan), and promoting export-oriented partnerships. Public policy also has a role in reforming the regulations and institutions for technological collaboration across MERCOSULcountries, to make them simpler, more flexible and more homogenous.

Finally, the case studies suggest that involving other organizations such as universities or business associations helps to promote technological collaboration. A decentralized way of increasing such cooperation among the actors of Sábato's extended triangle could be to provide vouchers for small business to get rapid access to the sources of knowledge necessary to improve process, products and services (Furtado, 1998).

NEW AGENDA FOR S&T COOPERATION IN LATIN AMERICA

A study prepared for the 1998 Latintec II meeting sponsored by UNCTAD compared the international cooperation modes which prevailed up to the 1980s with the newly emerging paradigm (Albornoz, 1998). Previously these modes emphasized orientation towards development; support for R&D; asymmetric structure (North-South); multilaterality; predominance of assistance modality; and support to public policies and academic sectors. In contrast, the new patterns were: support to innovation and technology development; predominantly associative modality; new multilaterality and emphasis on bilaterality; providing new value to horizontal south-south cooperation; support to private initiatives and association with private actors; and stimulus to collaboration between diverse actors.

The policies implemented under the former international cooperation paradigm had, in some measure, contributed to three major problems in Latin America which need to be tackled under the new agenda, according to the authors of the study. The problems are: (i) the increasing levels of *unemployment and underemployment*; (ii) the persistency and increase of *poverty*, and the increasing inequality in income distribution; and, (iii) the difficulties of reducing the gaps in mean *productivity ratios* with regard to the North.

The main course of action in Latin America, therefore, should be to promote the capability of the private sector to innovate and learn. In particular, it should aim at small enterprises not yet included in international networks of production and commerce. A variety of actions is proposed, many of them consistent with the triangular concepts mentioned above and the recommendations derived from the more restricted MERCOSUL case study.

The traditional divide between the high and low ends of the spectrum in S&T has been an unresolved issue in South-South cooperation. On the one hand, there is an obvious need to work on the frontiers of knowledge. On the other hand, scientists and technologists should be sensitive to the concrete demands of the surrounding societies. Both of these needs — rigorous method and social relevance — should shape the S&T agenda, as shown in examples collected by the UNDP and the Third World Academy of Science (TWAS). In addition to publicizing cases of promising applied research, institutions interested in promoting South-South cooperation could open a channel for sharing models of institutional processes which are both rigorous and relevant, with direct benefit to people, primarily the needy segments.

One concrete example is public research universities, which are main S&T assets in each country. They provide knowledge to the needy segment in the production sector — small companies, and new entrepreneurs — a segment highlighted in the new agenda for S&T cooperation. Universities acquired experience in performing research contracts for high-tech companies, and in establishing mechanisms to foster new high-tech ventures, such as business incubators or technology parks. This covers a very small, albeit very important, segment of the productive sector.

The concept of dual technologies, originally meaning knowledge useful for both military and civil purposes, could be used to promote knowledge useful for both high-tech and low-tech organizations. Some adaptations are obviously necessary to make the high-end developed knowledge applicable to low-end situations. This is not only feasible, but also constitutes an interesting innovation *per se*, as well as a source of specific research. Three examples from Brazil should illustrate this idea.

(a)Technology incubators of popular cooperatives. Universities have a recognized experience in establishing hi-tech incubators, mainly for spin-offs of academic research. Here, new entrepreneurs are sheltered, nurtured and informed of what the business world is like, and potential clients and funding agencies are attracted. The main idea is to reduce the risk of infant mortality of new ventures and to help entrepreneurs navigate in the new and still unfamiliar business environment.

This same incubator concept can be applied to cooperatives of unemployed people. Universities can encourage people from neighboring poor communities to establish a cooperative, help them find market niches, provide the necessary technical and managerial skills, gather funding for the first steps from the government or NGOs, and help attract clients. Usually the university itself can benefit from the products or services provided. Faculty and students from different areas get involved. The students gain the opportunity to apply in practice what has been taught in class and to develop skills and attitudes relevant to their careers. This model is being successfully applied in several Brazilian universities, giving rise to an associative movement of university-sponsored technological incubators of popular cooperatives. This movement is financially supported by FINEP, the national agency for financing innovation.

(b)Dial technology. How can universities become familiar, helpful places for leaders of small companies and new entrepreneurs? Many did not have the opportunity to go to college, do not know that universities have knowledge their businesses need to survive and be competitive, or would never dare go to this rather distant institution. The usual approach was for a university to market its supply of research capabilities through a university office of technology transfer. The reverse approach — attracting the demand — is employed by a user-friendly human and managerial system called "Dial Technology." By phone, fax, e-mail, mail, or personal visit, entrepreneurs convey their needs, which usually involve production or management troubleshooting. These are handled by staff or faculty, undergraduate or graduate students, or other specialized institutions.

The pioneering service was established in 1991 at the University of Sao Paulo (USP). The University pays for a small staff, and additional modest financing comes from a Brazilian non-profit organization which helps small enterprises (SEBRAE). The USP unit processes two thousand cases yearly, with 75 per cent satisfaction. This successful service has also been adopted by 16 other Brazilian universities and institutions, and also by two Argentine universities.

(c) Modernization clusters for collective efficiency. The question was how to help traditional industries such as clothing and furniture find new ways to overcome the pressure of foreign competition. The University has an inclination to create technology parks, providing common infrastructure for high-tech competing companies. In this case, it used its legitimacy as a neutral institution to put together low-tech competitors, help identify common problems in the cluster, establish associative solutions, and demonstrate the role of collective efficiency.

In the case of the clothing industry located in Americana, the aim is to improve quality and productivity, which was done by establishing a common maintenance facility and a common CAD/CAM system. In the case of the furniture cluster located in Votuporanga, the aim was to develop new products, and a shared new line of furniture for export was professionally designed. This project was performed by USP with the support of the São Paulo branch of SEBRAE. ▨

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India's Experience with TCDC

by ASHOK PARTHASARATHI

For almost 50 years, India has taken part in technical cooperation with other developing countries. Ashok Parthasarathi, Professor, Centre for Studies in Science Policy, School of Social Sciences, Jawaharlal Nehru University, New Delhi, India, offers a summary account of collaborative programs for science and technology in four areas: computerization, railways, solar energy, and technological information.

IT HAS BEEN A LONG-STANDING POLICY of the Government of India right from the time of Independence in 1947 to cooperate with other developing countries in science and technology, including assistance it can provide from its own development experience. As early as the mid 1950s students from many Asian and African countries came for higher education courses on scholarships provided by the Indian Government.

In 1964 the Government decided to put this cooperation and assistance on a firm footing and to expand and deepen its scope and character. It did this by setting up the Indian Technical Cooperation (ITEC) Programme in the Ministry of External Affairs. Since then, some 140 countries in Asia, Eastern Europe, Africa and Latin America have been invited to share our development experience — both successes and failures. By the end of 1998, ITEC had provided about 10,000 educational and training scholarships to other developing countries in a wide range of fields. It also had sent around 500 Indian specialists to help other developing countries' schools, colleges and universities, governmental structures, and training programs in areas as diverse as small-scale industry, telecommunications, transportation, medicine and public health. In addition, other government bodies have undertaken bilateral, regional and interregional projects with other developing countries, including India's agencies for agriculture, railways, telecommunication, education, science and technology, atomic energy and space. Since 1978, India has also committed 10 percent of the assistance it receives from UNDP to TCDC activities with other developing countries.

PROJECT INTERACT

A particularly important TCDC program was "Project INTERACT". During 1981-1984, it helped apply small/mini computer systems in three areas: (a) electric power systems management; (b) passenger reservation systems on railways; and (c) advanced weather forecasting using ground-based, airborne and satellite-based systems. The three projects were mainly designed by the Computer Maintenance and Services Corporation (CMC), a public sector company of the Department of Electronics of the Government of India, and one of the largest computer companies in the Third World. Computer specialists from Venezuela, Mexico and Yugoslavia worked on formulation and R&D for the electric and railways projects, and BPPT of Indonesia had a joint role in the weather project. The aim was to develop state-of-the-art computer-based systems tailor-made for developing country conditions and needs. The technologies flowing from the three projects were fully shared among participating countries, which were free to utilize them commercially in any manner, with no payments due and no encumbrances as to intellectual property rights. When the three projects were completed in 1984, an independent review commissioned by UNDP found that INTERACT was a substantial success, showing how collaboration among developing countries could develop advanced commercializable technologies optimal for use in developing country conditions.

SOLAR ENERGY

The Non-aligned Summit in September 1989 created a group of 15 developing countries, called G-15, which met in 1990 and selected several fields, including solar energy, for special cooperative R & D efforts. Recognizing that developing countries have a special advantage in solar energy, the program promotes solar energy applications and cost-effective production and utilisation of solar energy devices; sets up research and information facilities to enable effective flow of shared information; and develops qualified staff for the emerging field of solar energy applications. India was named program coordinator, based in the Solar Energy Centre (SEC) of the Ministry of Nonconventional Energy Sources (MNES), about 30 km from New Delhi. The other participating countries are Senegal, Malaysia and Egypt.

A collaborative project on solar photovoltaic electricity is being implemented in a Senegalese village near Dakar, with support from India. Solar installations there now include domestic lighting for its 285 houses, refrigerators for the maternity centre and for vaccine storage, and a public address system for the mosque. These were manufactured by the Indian public sector company Central Electronics Ltd. (CEL), fifth largest solar energy company in the world. Senegalese engineers trained in India joined in installing and commissioning the system.

A G-15 project on solar water heating being coordinated by Egypt involves testing of a solar collector manufactured in Egypt at India's Solar Energy Centre, and of an Indian solar collector in Egypt, through its Energy Ministry.

At SEC, a Data Bank and Information Centre on Solar Energy and its Applications has been operational since mid 1999. It obtains the latest information on solar energy developments worldwide, publishes a bimonthly "Solar Energy Information Service Newsletter", and operates a "query and reply service"for universities, R&D laboratories, industries and government departments in other participating G-15 countries.

An India-Syria bilateral project in 1995-97 set up a factory for solar electricity-generating panels and energy systems. The Syrian Scientific Research Council (SSRC) had planned to create a turnkey factory with Italy, but the price offered by the Indian company CEL for an identical plant was around half the Italian price, plus Syrian participation was maximized. CEL supplied fully documented technology and trained six SSRC engineers. Selection of suppliers, construction of the solar energy plant in Syria, and project evaluation were all joint India-Syria efforts. Commissioned in 18 months, the plant has been run by SSRC ever since. It makes and installs solar energy systems for rural water pumping, home lighting, street lighting, community TV sets, and radio-tape recorder/public-address systems for mass communication.

TCDC FOR RAILWAYS

Indian Railways (IR), the largest railway system in the world, operates some 11,000 trains a day. While growing fivefold since the late 1940s, the IR has also helped other developing countries build up their railway systems. It has done so through (a) technical assistance, consultancy and training provided by the public sector company of the Ministry of Railways known as RITES; and (b) commercial contracts by the sister public sector company IRCON. Over 25 years, these bodies have trained about 2,000 personnel from other developing countries. In addition, RITES fielded nearly 3,500 experts to assist railways in 14 developing countries, including nine African countries.

The range of activities undertaken by RITES has been wide:

- ***Bangladesh:*** Maintenance of locomotives from India, and air conditioning of coaches
- ***Botswana:*** Management support in civil engineering, finance, operations, commercial management, restructuring, productivity, and marketing.
- ***Ghana:*** 1) Rehabilitation and performance improvement, including professional-technical support in eight fields; 2) management studies of required staff numbers, departmental functions and management interrelationships; 3) setting up maintenance facilities for rolling stock.
- ***Iraq:*** 1) Operation, maintenance and training improvements for a railway section; 2) engineering studies for high-speed lines to cement factories and lime quarries; 3) other railway construction; 4) consultancies to modify Baghdad Yard for projected traffic in two coming decades.
- ***Mozambique:*** 1) Locomotive study, including comprehensive rehabilitation and upgrading of maintenance, infrastructure, investment and staff training plans; 2) technical assistance for management of railway system, including finance, training, maintenance, planning, operations.
- ***Nigeria:*** 1) Revitalization study, investment plan, corporate plan (1989-1998), and design of management information systems; 2) management of total railway system for three years to achieve operational and productivity targets and turn corporation into a profit maker.
- ***Tanzania:*** Leasing and maintenance of diesel locomotives manufactured in India.
- ***Zambia:*** 1) Installing operations improvement plan and productivity incentives scheme; 2) productivity study of maintenance workshop; 3) technical-professional services on maintenance and operations, modernization, accounting, management information systems.
- ***Zimbabwe:*** 1) Preparation of investment, operations improvement, and business plans; 2) technical assistance on maintenance and computerization.

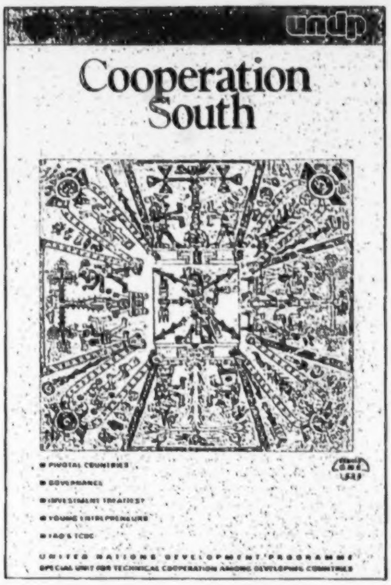
In addition, at least 22 commercial projects were undertaken by IRCON in Bangladesh, Indonesian, Iran, Malaysia, Nepal and Turkey. These include improvement, rehabilitation, construction and maintenance of rail lines and bridges, electrification and signalling, and leasing and maintenance of locomotives.

TECHNOLOGY INFORMATION PILOT SYSTEM (TIPS)

In 1984, the United Nations Development Programme (UNDP) sponsored the creation of the Technology Information Pilot System (TIPS). Its purpose was to promote technology transfer and technical and economic cooperation among developing countries by organizing continuous information exchange among the productive sectors of the economy and public, private and professional organisations. Initial participants were India, Philippines, People's Republic of China, Pakistan, Mexico, Peru, Brazil, Egypt, Zimbabwe and Kenya. They set up a network of national bureaux linked by communication circuits to an International Operations Centre (IOC) at Rome.

The bureaux collected information from many national sources, initially covering nine sectors: agro-industries, biotechnology, electronics, energy, fisheries, food processing, machinery, pharmaceuticals and textiles. This information was reviewed, translated and transmitted by the IOC in "South Tech" bulletins. These were for national distribution to companies, trade associations, government departments, R & D institutions and chambers of commerce. During the pilot phase, about 2,500 users received regular information with no subscription fee. A typical item was about 200 words, including contact information, and about 250-300 items were carried per month, all of which were of commercial interest. After the two-year pilot phase, a UNDP evalution found that TIPS was gaining recognition, and a two-year second phase was formulated. During that period, many initial users became subscription-paying customers, and national bureaux attracted others on a fee basis. Though TIPS had proven there was a market for a South-South information network, accelerated globalization in the early 1990s affected almost all of the participating countries. This tended to decrease South/South cooperative efforts, both at political and commercial levels, and there was also pressure to reduce government-subsidized programs. At the same time, advances in information technology, especially the Internet, made wide dissemination of commercial information easy and affordable. All these had their effects on TIPS. ◻

Recent Issues of Cooperation South



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PIVOTAL COUNTRIES

GOVERNANCE

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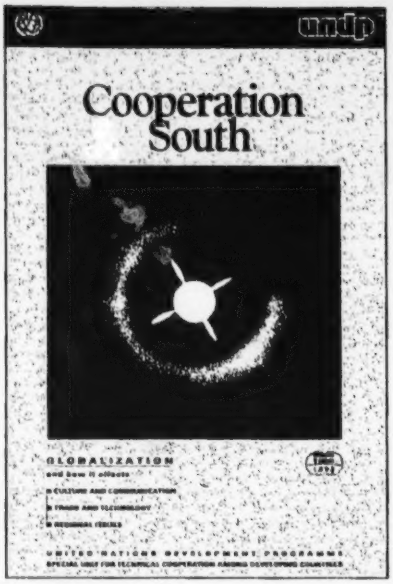

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and how it affects

CULTURE AND COMMUNICATION

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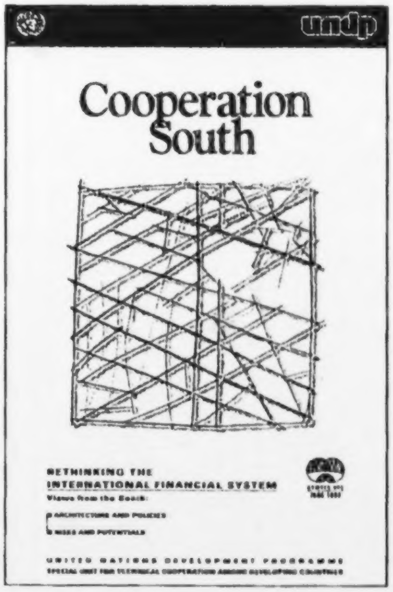

Cooperation South

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Views from the South:

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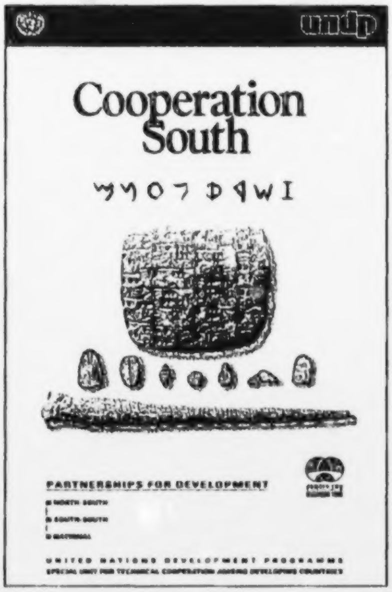

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Current trends, perspectives and events

Windows ON THE SOUTH

GROUP OF 77 SUMMIT: "MILESTONE" TOWARD DEVELOPMENT AND COOPERATION

THE GROUP OF 77 (G-77) held its first Summit meeting in April, with 55 Heads of State and representatives of over 120 countries and international organizations participating. The summit held a high-level interactive dialogue on four main topics — globalization, North-South relations, South-South cooperation, and knowledge and technology.

The summit was called "a milestone in our quest for development and the attainment of a just and equitable global economic order, based on peace and an effective arrangement of collective security," in the words of President Olesegun Obasanjo of Nigeria, who is the current G-77 chairman. He chaired the meeting, held in Havana, with President Fidel Castro Ruz of Cuba.

With 133 members, the G-77 is the largest coalition of developing countries in the United Nations, providing them with an important platform on economic and social issues. It was created by 77 developing countries at the first session of the United Nations Conference on Trade and Development (UNCTAD) in 1964.

In his opening statement, President Obasanjo called on countries of the North to "reverse the decline of core resources of UN funds and programmes that have traditionally brought meaningful improvement to the lives of our people", and to demonstrate their commitment to genuine partnership with the countries of the South. He also called for effective South-South cooperation based on regional and subregional economic integration, specific projects and programmes by both public and private sectors; and increased trade and commercial transactions. He expressed strong appreciation for the support of the United Nations, particularly UNDP, UNCTAD and UNIDO.

In his address, UN Secretary-General Kofi Annan called on developing countries to work more closely together, and said that South-South cooperation was now a pillar of UNDP operations. In September 2000 at the Millennium Summit, when world leaders define the kind of United Nations they want in the 21st century, "the South's voice should not only be loud, but clear, consistent and constructive," he said. He urged Heads of State to read his Millennium Report, with proposals to reduce poverty, curtail illegal small-arms trade and help poor countries benefit from the information technology revolution. He also urged wealthier countries to grant free market access to products of less developed countries, wipe out the debts of heavily indebted countries, and provide more generous development assistance to poor countries.

Interactive dialogue of Heads of State

The Summit held an interactive dialogue among Heads of State on the four main agenda topics. They stressed the need for G-77 to nullify the negative effects of globalization and harness its positive possibilities. Many leaders called for a new international order better suited to the requirements of sustainable human development. The HIV/AIDS pandemic, particularly in sub-Saharan Africa, needs most urgent attention since it hampers the development of many.

In the concluding session, the leaders adopted a Declaration and Plan of Action which charts a new course for developing countries in the years to come. It sees South-South cooperation as essential for promoting sustainable economic growth and development; supports recent initiatives for inter-regional cooperation between Africa, Latin America and the Caribbean, and between Africa and Asia, on shared problems such as drought and desertification; and underscores the need collectively to seek a lasting solution to the foreign debt burden of developing countries, including the structural causes of indebtedness. It also confirms the commitment to reach concrete accords, identify sources of funding, and design follow-up mechanisms. Nigerian Foreign Minister Alhaji Sule Lamido urged financing for a permanent secretariat that would help organize summits to assess progress made on agreements reached by G-77 leaders.

Council of Ministers

The Summit of Heads of State was preceded by a Council of Ministers mainly devoted to open dialogue on the role of the United Nations in the 21st century and its democratization and modernization. Some 40 ministers from developing nations took part, reiterating their faith in multilateralism, and recommending a greater UN role in socioeconomic development. For example, with digital technology 80 per cent concentrated in developed countries, the ministers called for closing that gap not by leaving it up to the private sector, but by involving the United Nations.

While urging developed countries to honor the broken promise of allocating 0.7 per cent of GDP to aid, the ministers saw that new sources of financing are needed for development as a result of declining ODA. Decreasing aid and the growing income and technology gaps between North and South, due largely to economic globalization, made it urgent for developing countries to cooperate more closely among themselves and with industrialized countries.

At national levels, the ministers recognized that good governance requires capacity building, and many developing countries lack the necessary skills and institutions. They also need to increase investment in education and training, energy, and social infrastructure, if the South is to catch up with the North and develop its full potential in those areas. ☐

DAKAR DECLARATION: SCIENCE ACTION PLAN FOR AFRICA

Science and technology should be put to work on such critical issues as "poverty eradication, health, peace, sustainable development and environmental protection." This is one of the key recommendations in the Dakar Declaration adopted last November by more than 300 scientists from 60 nations.

"Science and technology for sustainable development in Africa" was the theme of the Dakar meeting, which included eight ministers of science and technology from developing countries. Participants unanimously approved the Dakar Declaration, which contains a six-step action plan to:

- Create an international panel of scientific experts in such critical areas as information technology, biodiversity, and new and renewable energies to advise governments in Africa and throughout the developing world on science and technology issues.
- Develop centres of excellence in Africa and the developing world in which world-class basic research could be pursued through South-South and North-South cooperation.
- Establish regional and national innovation centres dedicated to exploring the relationships among

the basic sciences, technology, policy and management in Africa and throughout the developing world.

- Promote cooperation among scientists of African origin wherever they live to foster the investigation of issues important to Africa.
- Increase the participation of women in the study of science in Africa and throughout the developing world by working with such organizations as the Third World Organization for Women in Science (TWOWS).
- Prepare a background paper analysing the challenges of forging partnerships between the scientific community and private sector in Africa and throughout the developing world.

The unanimously approved Declaration also outlined the responsibilities of governments, scientific communities and international funding agencies to promote science-based development, improve science education, boost investments in scientific infrastructure, devise plans for advancing information technologies, expand opportunities for female scientists, protect international property rights, and establish biosafety regulatory statutes.

The Declaration emphasizes two main needs, according to José I. Vargas, President of the Third World Academy of Sciences (TWAS) and Third World Network of Scientific Organizations (TWNSO). The first is "the creation of cooperative frameworks that extend across traditional boundaries, whether defined by geography, politics, economics or academic disciplines." The second is the need for "science and scientists to play more active roles in the creation, implementation and assessment of economic development strategies."

The occasion marked the regular general meetings of TWAS, TWNSO and AFRISTECH, a foundation that supports science and technology in Africa. Conference sponsors included the French Academy of Sciences; International Development Research Centre (IDRC), Canada/Senegal; Norwegian Development Agency (NORAD); United Nations University (UNU); World Meteorological Organization (WMO); Organization of the Islamic Conference (OIC), Standing Committee on Scientific and Technological Cooperation (COMSTECH); and the Commission on Science and Technology for Sustainable Development in the South (COMSATS). ☐

WIDE NOMINATED FOR INTERNATIONAL INFORMATION TECHNOLOGY AWARD

The Web of Information for Development (WIDE), an internet-based information system of the Special Unit for TCDC, was among the finalists in the Stockholm Challenge Award 2000. The

Challenge showcased projects of excellence and shared knowledge and experience in information technology from around the world, focusing on the benefits and changes IT brings to local and global communities. It is a nonprofit initiative of Stockholm City in partnership with the European Commission.

Over 600 projects participated in the seven categories covered by the Challenge — new economy; health and quality of life; culture and entertainment; public services and democracy; education; environment; and equal access. WIDE was one of fourteen finalists selected from 95 projects in the equal access category. Finalists were selected by an international jury of senior experts. Creativity, innovation, using technology in new ways, enriching individuals and organizations, and stimulating and sharing knowledge were some of the selection criteria.

Winners were announced in June 2000, in Stockholm, which also hosted a grand exhibition. Additional information is available at http://challenge.stockholm.se ☐

FREE E-MAIL IN COSTA RICA

Costa Rica is becoming " the first society in the world in which e-mail is free and open to all," according to President Miguel Angel Rodriguez. Two government services have launched a six-month pilot project that will enable users with access to computers also to surf the Internet free of charge.

Called "Punto.com", the project is operated by the Costa Rican Postal Service and Radiografica Costarricense (Racsa). It is expected to be extended to all of Central America and the Dominican Republic. ☐

THE SEOUL ACCORD

Adopted by the Forum on South-South Cooperation in Science and Technology

14-17 February 2000, Seoul, Republic of Korea

We, the participants of this Forum on South-South Cooperation in Science and Technology (FOSAT), meeting in Seoul, Republic of Korea, from 14 to 17 February 2000, recognizing the enormous challenges of development facing the countries of the South; convinced of the vast opportunities that science and technology offer in meeting these challenges through South-South cooperation; and committed to a comprehensive programme for the effective and sustained implementation of the objectives of this Accord, hereby

Consider that

- Science and technology be promoted and accorded high priority as a means of addressing basic human needs, including poverty alleviation and human development.

- Critical individual and collective developmental capacities of the South be built and sustained, taking full advantage of the benefits of advances in science and technology.
- Focus be placed on existing and new modes of cooperation, especially in areas such as biodiversity, biotechnology, information and communication technology, and renewable energy.
- Viable mechanisms be established or strengthened to foster South-South science and technology cooperation.

Recommend the following actions:

- Establish a South-South network, linking R&D institutions and other centers of excellence in order to enhance our collective efforts in the generation and use of knowledge.
- Establish effective mechanisms to facilitate technological cooperation among firms in each of our countries, in order to be more competitive internationally, among which setting up information systems aimed at identifying common projects and needs where collective actions would lower the costs for all participants would be particularly valuable.
- Increase the human capital base by pooling efforts on education and relevant training programs with special emphasis on women.
- Share experiences regarding the contribution of science and technology to food security and poverty alleviation in our countries and expand on their applications.
- Establish strategic South-South programmes of R&D on the development of vaccines, drugs and diagnostics for the prevention and cure of major communicable diseases in the South, such as malaria, tuberculosis and HIV.
- Devise and support mechanisms that would enable countries of the South to pool their technical, institutional and financial resources to undertake and catalyze South-South cooperation in science and technology for development.

We thank the Government of the Republic of Korea, the United Nations Development Programme (UNDP) and its Special Unit for Technical Cooperation among Developing Countries for sponsoring and organizing this important forum.

SHARING IDEAS

COOPERATION SOUTH is devoted to critical analysis and discussion of development issues of importance to the South. To this end, it welcomes the exchange of ideas and experience from all sectors, disciplines and viewpoints, and from sources ranging from policy-makers and scholars, to practitioners and community activists.

Readers wishing to take an active part in this dialogue are invited to comment on articles published in the journal and to contribute articles for possible publication. Letters and manuscripts, which are subject to editing, should be sent to the Editor-in-Chief, Cooperation South, as follows:

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Information and Communications Technology for Development

...I do want to just briefly make to you the argument that the Internet is a totally different, new dimension to development than anything we have recently seen. And the reason is twofold. First, when you compare it to other communications technologies, the barriers to entry are not present when it comes to the Internet. You do not need the high investment cost of putting phone lines down that you did for old style telephony, barriers which mean that even to this day at least two billion people in the world have never made a phone call. You have the possibility of wireless connection, which will be able to carry not just voice but data and visual images, as well.

And you have a dramatically falling cost of Internet connectivity, not just in terms of the cost of wireless transmission, but of the technology itself. And, here for the U.S. market, there are under design Internet receivers which have only a potential $50 retail cost for them.

So the idea that the Internet is going to be an unaffordable medium in the developing world for very long is, I think, wrong. And I honestly believe that the barriers to entry are going to be much more cultural and public policy than they are going to be financial or economic. I think there is a real risk that the digital divide will become a self-fulfilling prophecy. That on the part of northern IT corporates there will just be the view that a lot more money is to be made out of the developed markets; why take on the risk of expanding into developing markets?

And I think on the part of governments in developing countries, there is a risk that it will be seen as an instrument of American cultural expansion. That people won't look beyond that and see its real liberating power, its capacity to bring distance learning and connection to world markets into the most isolated villages and communities in their country.

I have already engaged with many of my friends in developing countries to try and argue that, far from this communications revolution being another revolution which will reward those with capital to invest in education — the Hollywoods of this world — the glory of the Internet is that it is actually one of the lowest cost tools in terms of creating content. Anybody can create a Web page. You do not need $1 million like you do to make a Madison Avenue TV spot. You don't need $50 million, as you do to make a Hollywood movie. All you need is creativity and a little bit of basic knowledge to make a Web page. This can be a technology owned and participated in by everybody.

And the second dimension, why it is different from the appearance of a new vaccine or a breakthrough on a particular food product, or even a transforming issue like micro credit for the developing world, is that, a bit like the transformative aspects of the Industrial Revolution, it touches every productive process in an economy. It transforms economic relations in every way.

I think it has that capacity for developing countries as much as it does for developed. If we can create the right public/private partnerships, this can overcome public policy and cultural obstacles that definitely lie in the way at the moment.

Excerpt from the statement made by Mark Malloch Brown, Administrator of the United Nations Development Programme at the Society for International Development, New York Chapter, 16 February 2000.

HUMAN DEVELOPMENT REPORT 2000

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The eleventh edition in the series, *HDR2000: Human Development and Human Rights*, provides a thought-provoking analysis of these two approaches. Human rights and human development are mutually reinforcing, culminating in enlarged human freedom. The Report traces the history of struggle for human rights as a common human experience and outlines the new frontier of the rights agenda for the 21st Century. HDR2000 demonstrates the ways in which human rights enrich human development goals, adding moral force and ideas of claims, duties and obligations. Human development, in turn, brings a dynamic long-term perspective to human rights, and adds more concrete analysis, quantification and the human rights impacts of policy choices. The Report analyzes how human rights must be respected, protected and promoted in the development process. To that end, it addresses the accountability of governments to fulfill their duties, as well as a timely analysis of the duties and obligations of newer actors. This includes corporations, NGOs, individuals, the international community and markets—particularly how the current global economic rules and institutions address human rights issues. It proposes strategies for promoting development that also protect and further human rights, with significant implications for a pro-human rights approach to development. Human Development Report 2000 updates the unique Human Development Indicators, ranking human development in most countries of the world, and presents data tables on all aspects of human development.

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WIDE OnLine: A knowledge base of developing countries' experts, institutions, publications, "best" practices

InterLink: A network of TCDC stakeholders sharing the WIDE electronic venue to build capacity

DESIGNING THE FUTURE:

South-South Cooperation in Science and Technology

OVERVIEW

- **THE HISTORY AND URGENCY OF SOUTH-SOUTH COOPERATION:** Not just common problems but also increasingly unequal technological levels open broad avenues for cooperation among developing countries, say John F.E. Ohiorhenuan and Amitav Rath.

INNOVATION AND COOPERATION

- **CHALLENGES, OPPORTUNITIES AND STRATEGIES IN SOUTH-SOUTH COOPERATION:** Research & development capacities should be significantly increased and combined to work on everyday needs and strategic requirements across the South, according to Mohamed Hassan.
- **CHANGE OF PARADIGM IN SCIENCE AND TECHNOLOGY POLICY:** It's time for developing countries fundamentally to rethink how they deal with science and technology, and Carlota Perez signals some needed changes.
- **BUILDING A KNOWLEDGE-BASED DEVELOPMENT STRATEGY:** Clive Thomas leads a realistic discussion weighing some needed practical actions and support policies.
- **PRINCIPLES, CRITERIA AND PRIORITIES FOR KNOWLEDGE SHARING:** Jorge Ahumada-Barona offers ideas about how to join forces across the South to develop and deploy new scientific and technological knowledge.
- **PRIORITY SECTORS AND ACTIONS FOR SCIENCE AND TECHNOLOGY COOPERATION:** Four sectors and four actions hold particular interest for developing regions seeking to collaborate in science and technology, says Ousmane Kane.
- **KNOWLEDGE-BASED INDUSTRIAL DEVELOPMENT AND COOPERATION:** Business survival in the South means adopting a more knowledge-intensive approach and seeking continuous innovation, argue Lynn K. Mytelka and John F. E. Ohiorhenuan.
- **DEFINITIONS, QUESTIONS, VISIONS:** How to balance long-term research on the frontiers of knowledge with targeted problem-solving? Joseph Okpaku looks at the social, intellectual and techno-economic dimensions for the future.

EXPERIENCE FROM THE REGIONS

- **FROM IMITATION TO INNOVATION:** Developing countries need to find "a new growth engine based on technological innovation." Hokoon Park explores approaches and methods for doing this.
- **S&T INNOVATION AND COOPERATION IN LATIN AMERICA:** Guilherme Ary Plonski calls for reshaping the region's agenda and joining forces among many actors to tackle problems of employment, poverty and productivity.
- **INDIA'S EXPERIENCE WITH TCDC:** Ashok Parthasarathi summarizes India's collaborative programs for science and technology in computerization, railways, solar energy, and technological information.

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